ADVANCED RESEARCH WORKSHOP

MONITORING OF NATURAL AND MAN–MADE RADIONUCLIDES AND HEAVY METAL WASTE IN ENVIRONMENT

TENTATIVE PROGRAM

ABSTRACTS

C349r(04)
A-22

JOINT INSTITUTE FOR NUCLEAR RESEARCH

ADVANCED RESEARCH WORKSHOP

MONITORING OF NATURAL AND MAN–MADE RADIONUCLIDES AND HEAVY METAL WASTE IN ENVIRONMENT

3-6 October, Dubna, Russia

Flerov Laboratory of Nuclear Reactions
and Frank Laboratory of Neutron Physics
of the Joint Institute for Nuclear Research, Dubna, Russia
with the support of
NATO Science for Peace Program

Scientific Council on Applied Nuclear Physics
of the Russian Academy of Sciences
and
International University of Nature, Society and Man, Dubna, Russia

Tentative Program

Abstracts

Dubna 2000

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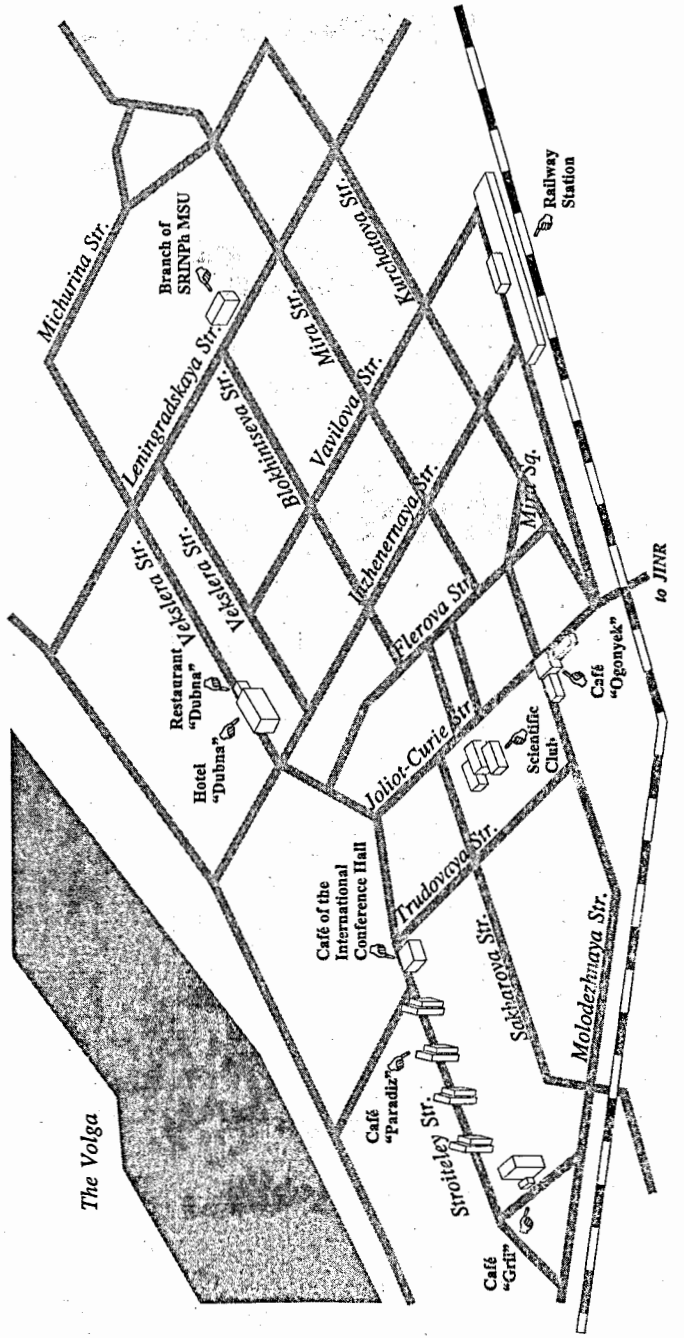
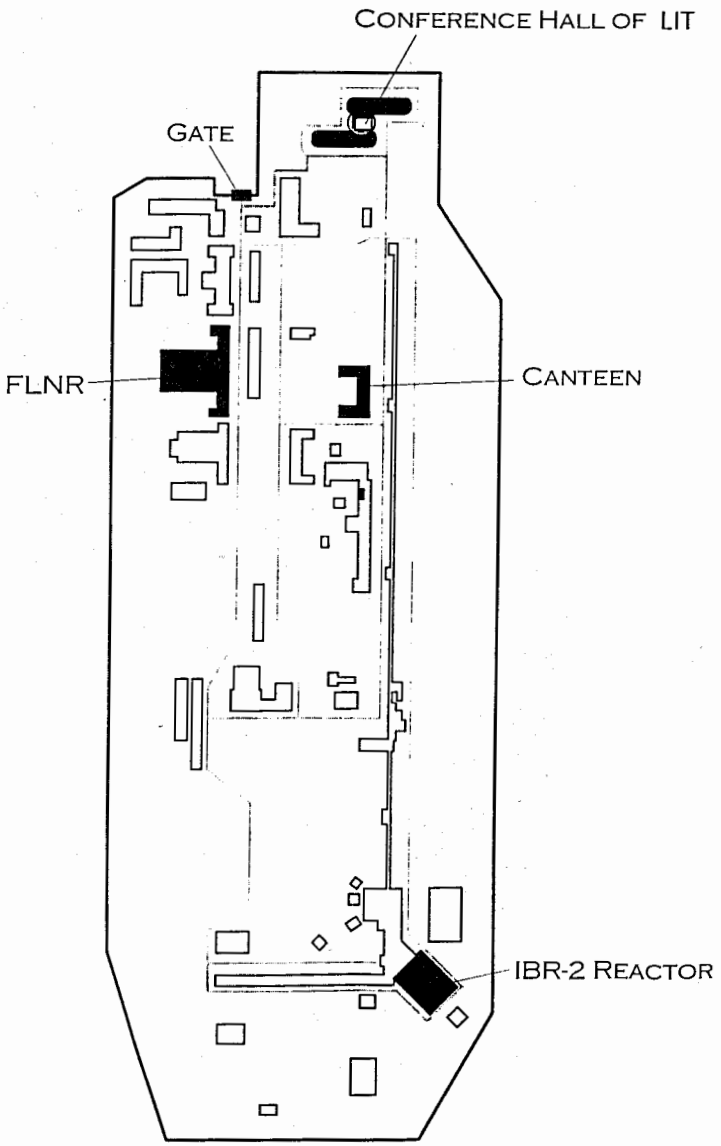
ISBN 5-85165-584-4

PLAN OF DUBNA



JINR Territory



TENTATIVE PROGRAM

TENTATIVE SCIENTIFIC PROGRAMME OF THE WORKSHOP

Monitoring of Natural and Man-Made Radionuclides and Heavy Metal Waste in Environment

(Dubna, Russia, 3-6 October, 2000,

Conference Hall of the Laboratory of Information Technologies, LIT, see the enclosed the JINR Territory map)

October 2, Monday 17.00-20.00	Registration in the hotel «Dubna»
October 3, Tuesday 9.00 9.30	Registration (in the lobby of the Conference Hall of LIT) OPENING V.P. Perelygin, P. Vater, M.V. Frontasyeva, V.G. Kadyshevsky, Yu.Ts.Oganessian
10.00	*Coffee Break and Collective Photo*
	PLENARY SESSION 1 Man-Made Radionuclides in Biosphere ***Chair: P.Vater (Germany)***
10.30	B.F. Myasoedov (Russia). Radioactivity and Environment
11.00	R. Wilson (USA). The Major Environmental Issues at the Start of the 21st Century
11.30	N.D. Priest (UK). Accelerator Mass Spectrometry for Plutonium Isotopes
12.00	D. Newton (UK). Tracking the Behaviour of Plutonium in Man
12.30	A. Bleise (Austria, IAEA) Internationally harmonized approach to biomonitoring trace element atmospheric deposition
13.00	*Lunch*
	PLENARY SESSION 2 Heavy Metal Atmospheric Deposition ***Chair: J.Stamenov (Bulgaria)***
14.30	A. Ruehling (Sweden). Survey of Atmospheric Heavy Metal Deposition in Europe Organization of the Project
15.00	E. Steinnes (Norway). Use of Mosses as Biomonitors of Heavy Metal Deposition: from Relative to Absolute Deposition Values
15.30	M.V. Frontasyeva (Russia, JINR). Atmospheric Deposition of Trace Metals Studied by Moss and Lichen Analysis: Some Examples from Russia
16.00	*Coffee Break (& Posters Session 1)*
	PLENARY SESSION 3 Heavy Metal Atmospheric Deposition (continued)

	Chair: E.Steinnes (Norway)
16.30	K. Grodzinska (Poland). Heavy Metal Moss Monitoring in Industrial Regions of Poland
17.00	Z. Jeran (Slovenia). The Use of Lichens and Mosses to Monitor Trace Element and Radionuclide Pollution in Slovenia
17.30	Zhang Zhaohui (China). Moss Transplanting Technique Used to Study Heavy Metal Atmospheric Deposition in China
19.00	*Welcome Party (Canteen near FLNP JINR)*
October 4, Wednesday	**PLENARY SESSION 4** Actinides in Environment
	Chair: R.Wilson (USA)
9.00	V.P. Perelygin (Russia, JINR). Plutonium in Environment - Possible Serious Hazard for Human Health
9.30	V.Kosyakov (Russia). On Determination of Man-Made Transuranium Elements in Environment Samples (Air, Water, Soil)
10.00	M.K.Kievets (Belarus) Determination of Actinides in Biological samples in Belarus
10.30	*Coffee Break (& Posters Session 1)*
	PLENARY SESSION 5 Nuclear Instruments & Methods
	Chair: M.Monnin (France)
11.00	P.Vater (Germany). The Use of Nuclear Track Technique in Environmental Investigations
11.30	M.A.Chaudhri (Germany). Accelerator Based Radioanalytical Methods for the Analysis of Environmental Samples
11.50	A.A.Dyakov (Russia). Methods of High-Sensitive Analysis of Actinides in Liquid Radioactive Waste
12.10	V.I. Kudryashov (Belarus). The Contamination of Belarus Territory by Transuranium Elements
12.40	S.O. Aytas (Turkey) Levels of Polonium-210 in Plants of Turkey
13.00	*Lunch*
	PLENARY SESSION 6 Environmental Monitoring ***Chair: A.Chatt (Canada)***
14.30	J.S.Stamenov (Bulgaria). Monitoring and Management of Mountain Environment
15.00	Ye.I. Grosheva (Russia). Heavy Metals in the Lake Baikal Ecosystems
15.30	D.S. Gafitullina (Uzbekistan) NAA of Bottom Sediments from the South-West Part of the Black Sea
16.00	*Coffee Break (&Posters Session 1)*

	PLENARY SESSION 7 Radionuclides in Environment
	Chair: D.Klein (France)
16.30	G.N. Bondarenko (Ukraine). Isotopic Composition of Uranium in the Products of Accidental Ejection from the Chernobyl Nuclear Power Plant
16.50	O.D.Maslov (Russia, JINR). Trace Element Analysis of Actinides in Natural Waters and Soil Using (γ, F) Reaction
17.10	G.Yaprak (Turkey) Determination of Natural Radioactivity in Soils of Anatolia
17.30	L.L.Kashkarov (Russia). Chernobyl «Hot Particles»: Radionuclide Composition and Contribution in the Total Soil Radioactivity
17.50	S. Gerbish (Mongolia) Determination of Radionuclides, Toxic Heavy Metals and Trace Elements In Environmental Samples
19.00	*Reception in the Department of Activation Analysis, FLNP*
October 5, Thursday	**PLENARY SESSION 8** Radionuclides in Environment, Rare Gas and Earthquakes
	Chair: N. Priest (UK)
9.00	M.Monnin (France) Radon over Volcanic and Seismic Areas
9.30	D.Klein (France). Development of Simultaneously Radon and Gamma Measurements to Carry out Monitoring in the Environment - Applications to Survey of Nuclear Waste Storage
10.00	V.A.Alekseev (Russia). Radon Field Variation and the State of Ionosphere as the Most Reliable Earthquake Precursors
10.30	*Coffee Break (&Posters Session 2)*
	PLENARY SESSION 9 Radionuclides in Environment, Rare Gas and Earthquakes (continued) ***Chair: V.P.Perelygin (JINR)***
11.00	V.I. Nevinsky (Russia). One-Minute-Variations of Some Natural Elements in Black Sea Zone
11.20	J.Ishankuliev (Turkmenistan). Dynamics of Sub-Soil Radon within the Geodynamically Active Regions of Turkmenistan
11.40	K. Kaviladze (Georgia). The Complex Method of Observation at the Rn, H2, He, Ne, Organic Gases and Heavy Elements from Aerosols in Order to Predict
12.00	J.W. Mietelski (Poland). Radionuclides in Bones of Wild, Herbivorous Animals from North-Eastern Poland
12.20	O.B. Blum (Ukraine). The Pollution of the Environment Caused by Lead Dumping after the Chernobyl NPP Accident - Myth or Reality?
12.40	V. Mironov (Belarus). Destruction of Fuel Particles of the Chernobyl Fall-Out on Belarus Territory
13.00	*Lunch*
14.30	**Excursion to JINR Laboratories**
19.00	Conference Dinner, Restaurant of Hotel «Dubna»

October 6, Friday	**PLENARY SESSION 10** Heavy Metals in the Environment (Exotoxicology) ***Chair: D. Belluck (USA)***
9.00	A. Chatt (Canada). Studies of Selenium and Selenoproteins in Foods by Neutron Activation Analysis
9.30	V.D. Cherchintsev (Russia). On the Problems of Regional Ecotoxicology
10.00	T. Pinheiro (Portugal). Nuclèar Techniques for Toxicology and Environmetal Health Studies
10.30	*Coffee Break (&Posters Session 2)*
	PLENARY SESSION 11 Heavy Metals in the Environment ***Char: M.V. Frontasyeva (Russia)***
11.00	Eu. Pincovschi (Romania). Radionuclides and Heavy Metal Pollution in Romania
11.20	D. Belluck (USA). Environmental Sampling and Analysis of Coal Fly Ash intended for Use in Roads: Minnesota Department of Transportation Findings and Their Potential impacts on Environmental Health Decision-Making
11.40	V.V. Nikonov (Russia). Trace elements in Al-Fe Humus Podzols of Boreal Forests
12.00	V.P. Solodukhin. Radiecological investigations in Institute of Nuclear Physics of the Academy of Sciences of Kazakhstan
12.20	M. Biziuk (Poland). Determination of Heavy Metals in Human Milk and Hair
12.40	L.I. Zhuk (Uzbekistan) Human Hair Composition in Environment Monitoring and Mapping
13.00	*Lunch*
	PLENARY SESSION 12 Nuclear Transmutation ***Chair: V.P.Perelygin***
14.30	R.Brandt (Germany). Neutron-Physical Characteristics of Systems «U/Pb Target – Relativistic Protons» in the Energy Range from 0.5 to 7.4 GeV
15.10	V.S.Barashenkov (Russia, JINR). The State of Art Electronuclear Technology for the Inceneration of Plutonium
15.40	I.V.Zhuk (Belarus). Neutron-Physical Characteristics of Systems «U/Pb Target – Relativistic Protons» in the energy Range from 0.5 to 7.4 GeV
16.00	*Coffee Break (& Poster Session 2)*
16.30	**ROUND TABLE DISCUSSION (FLNP Conference Hall)** Projects: 1) Workplace Monitoring and Health Related Studies – Ongoing Project COPERNICUS ***Chair: S.M. Lyapunov (Russia)*** 2) Monitoring of Radionuclides and Heavy Metals in the Northern Kazakhstan, Mongolia and China Affected by Semipalatinsk Nuclear Test Site ***Chairs: M.V. Frontasyeva (Russia, JINR), E.Steinnes (Norway)***
16.30	**ROUND TABLE DISCUSSION (Conference Hall)** Projects: 1) Plutonium in Environment; 2) Earthquakes Predictions ***Chair: V.P. Perelygin (Russia, JINR), M. Monnin (France)***

Poster Session 1, October 3-4

1. S.A.Gromov, V.A.Ginzburg, S.J.Paramonov, Heavy Metals in the Environment over Russia: Data of the Integrated Background Monitoring Network for Last Decades.
2. A.Voloch. Chemical Elements in Atmospheric Air of Moscow.
3. A.Lucaciu, L.Timofte, I.Vata, L. Mattescu, C.D. Oprea, M.V.Frontasyeva, O.Stan, S.S.Pavlov, E. Stainnes, F.Cozma, S.Sasaran. Atmospheric Deposition of Trace Elements in Romania Using the Moss Biomonitoring Technique.
4. L.I.Smirnov, M.V.Frontasyeva, V.D. Chrchintsev, S.V. Lyapuniv, E.Stennes. Atmospheric Deposition of Heavy Metals in the South Ural Mountains, Russia.
5. Ye.V. Yermakova, M.V. Frontasyeva, E.Steinnes. Eputhermal Neutron Activation Analysis of Mosses Used to Monitor Heavy Metal Atmospheric Deposition in Tula Region.
6. T.F. Mikryakova, V.Y.Komov. Contents of Metals in Glues and Phizome of Water Plants from Laked of Northwest of Russia.
7. V.T.Komov, I.K.Stepanova. Contents of Mercury in Fish from Reservoirs of Northwest Russia: Main Causes of High Levels.
8. T.N.Shekhovtsova, N.A.Bagirova, I.A.Veselova, S.V. Muginova. Enzymatic Method for Heavy Metals Determination in Waters and Soils.
9. S.V. Morzhikhina, V.V.Uspenskaya, L,P,Chemnykh, I.L.Khodakovsky, M.V.Frontasyeva, S.F.Gundorina. Nuclear and Related Analytical Techniques Used to Study Anthropogenic Impact of the River Sister in the Vicinity of the Town of Klin (Moscow Region, Russia).
10. Yu.T.Chuburkov. Relative Elements Content in Oils and Living Organisms.
11. O.V.Alekseeva, L.G. Kuzmenko, M.V.Frontasyeva, S.F.Gundorina. Heavy Metals in the Hair of Children Suffering from Bronchial Asthma and Living in an Ecologically Clean District.
12. L.M.Moulishvili, Ye.I.Kirkesali, M.V.Frontasyeva. Iodine- and Selenium-Containing Pharmaceuticals Based on the Blue-Green Algae *Spirulina platensis* Matrix. Neutron Activation Analysis for Practical Medicine.
13. Paula A.Lopes, Teresa Pinheiro, Marina Cristina Santos, Maria da Luz Mathias, Maria Joao Collares-Pereira and Ana Maria Viegas-Crespo. Antioxidant Indicators in Fresh Water Fish Populations (*Leuciscus alburnoides*) Exposed to Inorganic Pollutants at a Copper Mine Area.
14. S.Turchenko, Eu.Vostrolhnoutov, P.Vaganov, David Le Mone. Experience of the Using of Russian and American Satellite Data to Identify a Stable Block into Precambrian Formation of NW Russia for Modeling HLRW Disposal.
15. Yu.T.Chuburkov. Chemical Nature of Seismic Phenomena.
16. G.G.Popova, I.O.Nevinsky, T.V.Tsvetcova. The Chemical Parameters of Mud Volcano Waters Measuring.
17. J.Ishankuliev, B.N.Gaipov, S.P.Tretyakova, V.P.Perelygin, B.A.Muradov, B.Kerimov. Dynamics of Sub-Soil Radon within the Geo-Dynamically Active Regions of Turkmenistan.
18. L.A.Tsertsvadze, T.D.Dzadzamia, M.V.Frontasyeva. Potentialities of Bacterial Leaching from Lean Ores, Rocks and Industrial Wastes in Georgia Studied by Neutron Activation.

Poster Session 2, October 5-6

1. S.N.Dmitriev, N.G.Zaitseva, O.D.Maslov, G.Ya.Starodub, A.V.Sabelnikov, S.V.Shishkin and T.V.Shishkina. Radioisotopes in Life Sciences. The Production of High Purity Sources at FLNR JINR.
2. A.Y.Miroshnikov, A.A.Asadulin, A.L.Kerzin. On Determination of Radioactive Contamination and Geochemical Properties of the Ob and Yenisey Estuary Sediments.
3. N.P.Andreeva, A.Sh.Gaitinov, I.Ya.Chasnikov. Dating of Radiational Contamination of a Locality in Southern Regions of Western Kazakhstan.
4. Dinh thi Lien, Z.Szeglowski, H.Godunowa, Hang duc Nhan, Le khanh Phon, Luu tam Bat, Lam vinh Anh. Radioecological Analysis of Viet Nam Soil Samples.
5. G.S.Gelezhnyak, I.O.Nevinsky, T.V.Tsvetcova. Determination of Na-22 in Krasnodar Reservoir Waters.
6. Z.A.Kovtun, V.I.Gorbunov. Distribution of Radionuclides in Water and their Detection.
7. Yu.A.Sapozhnikov, St.N.Kalmykov, R.A.Aliev, K.M.Shimkus. Some Natural and Man-Made Radionuclide Profiles in the Bottom Sediments of the Black Sea.
8. J.V.Bondar, V.P.Perelygin. Non-Destructive Method of Pu and U Isotope Determination in Specimens.
9. V.S.Iakovleva, E.V.Golovanova, V.D.Karataev, Yu.G.Zubkov, Yu.A.Gromov, V.B.Elagin. Role of Radon in a Complex Radiation-Hygienic Estimation of Kindergartens.
10. R.Ilic, J.Skvarc, I.Lengar. Monitoring of Radon Decay Products.
11. T.Ruskov, L.Dimitrov, B.Kunov, E.Moravska, D.Lefterov, D.Petkov. Low Activity Beta-Alpha Radiometer (LABAR).
12. I.O.Nevinsky, T.V.Tsvetcova. Investigation of Radioisotopes in Mercury Plant Production.
13. V.P.Perelygin, O.S.Zaveriukha, B.N.Kulakov, M.I.Krivopustov, I.G.Abdullaev, G.P.Knjazeva, R.I.Petrova, R.Brandt, M.Ochs, J.S.Wan, P.Vater. Fission of the Pb Nuclei Induced by E>0.5 GeV/AMU p,d, He and ^{12}C Projectiles in the Volume of Massive Pb, Hg and U Target.
14. V.V.Pronko, I.O.Nevinsky, V.I.Nevinsky, T.V.Tsvetcova. Big Multiwire Proportional Chamber for the Detection of T, Cl-36, Kr-85 and Uncommon Nucleus in Nature.
15. G.A.Bojikov, P.I.Ivanov, A.N.Priemishev, G.D.Bonchev, M.V.Milanov, O.D.Maslov, S.N.Dmitriev. Determination of the Diffusion Coefficient of In, Cd, Zr, Hf and Pu Hydrated Ions in Water Solutions Using the Method of Horizontal Zone Electrophoresis in a Free Electrolyte.

ABSTRACTS

RADIOACTIVITY AND THE ENVIRONMENT

B.F.Myasoedov

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Environmental problems are known to be among the most important issues of humankind. Solutions to these problems in Russia are considerably aggrevated by heavy nuclear pollution in many regions of the country. A number of factors have made artificial radionuclides a persistent and very dangerous environmental problem. Among these are tests of nuclear weapons in the atmosphere and underground; the activity of nuclear power plants with nuclear fuel cycles producing and accumulating weapon-grade plutonium (USA: Hanford, Savannah River, and Idaho; Russia: Mayak Production Association in Ozersk, Siberian Chemical Plant in Seversk, Mining and Chemical Plant in Krasnoyarsk- 26); the activity of nuclear power stations and, especially, numerous accidents that occur at them; and unsanctioned submersion of nuclear waste and disposal of active solutions from ships and submarines with nuclear power units into various regions of the ocean. Rehabilitation of territories contaminated with radionuclides is an important environmental, economical, and social problem.

The current radioecological situation around the reprocessing plant "Mayak" constructed over 40 years ago for the production of plutonium for military purposes, is overviewed. The following topics are discussed: Karachay Lake; artificial water reservoirs contaminated by radionuclides; solid radioactive wastes and their vitrification. Some new approaches, methods and tools developed in the Vernadsky Institute of the Russian Academy of Sciences for determination of different radionuclides in various environmental samples from the impact zone of the facility are discussed. Data on the distribution, occurrence forms and migration processes of ^{90}Sr, ^{137}Cs, ^{239}Np, ^{239}Pu and ^{241}Am in aquatic and terrestrial ecosystems are presented.

THE MAJOR ENVIRONMENTAL ISSUES AT THE START OF THE 21ST CENTURY

Richard Wilson

Mallinckrodt Professor of Physics
Harvard University, USA

As we enter the 21st century it is important to take stock of where we are. Life expectancy in most of the developed world and has reached 79 for non smoking Americans. Until 1970, the life expectancy in the USSR was only slightly less than that of the USA, although it has recently decreased. It is important to recognize that this decrease is not due to direct government action but is due to personal behavior - which is controllable if we so wish. Nonetheless it is tempting to blame someone else for one's troubles - because then one has to do nothing.

There is a great public concern of the "radiation legacy of the 20th century" or more precisely the cold war. During that time we had several accidents in the USSR. Techa river, Mayak, Kyshtym and finally Chernobyl (and of course Three Mile Island in the USA). These incidents dominate much political thinking. But the most extensive of these - Chernobyl - used (perhaps) 20,000 cancers world wide, (although a lot of disruption). In contrast air pollution in Russia probably causes 20,000 premature deaths each year. In less fortunate parts of the world, such as Bangladesh, 120 million people are exposed to high levels of arsenic as a consequence of well meaning, but misguided attempts to help that poor country develop a pure water supply to avoid recurring cholera epidemics.

How can we prevent such mistaken help in the future which has led to such disaster? As we discuss the specific problems of our local regions, and our specific professions, it is important to keep this overall perspective. I was very impressed by the zeal of a young Russian architect I met in Moscow in 1979: "I want to use my skills in a developing country where they will be of most use". I will focus on the important issues and the extent to which our knowledge of radiation and radioactivity can help.

ACCELERATOR MASS SPECTROMETRY FOR PLUTONIUM ISOTOPES

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The efficacy of accelerator mass spectrometry for the ultra-trace detection of plutonium isotopes is now well established. This technique, commonly referred to as AMS, is able to detect levels of specific plutonium isotopes in biological samples (down to ag / fg levels) that are well below those that may be achieved by conventional techniques, including alpha-spectrometry and ICP-MS. Moreover, the time taken for sample analysis is short (<1hr) compared with the time required for sample analysis by low-level alpha-spectrometry (possibly several months). The method also offers substantial advantages over other ultra-low level detection methods such as TIMS and fission track counting. This is because it suffers to a much lesser extent (or not at all), than the former, from isobaric interference and, unlike the latter, employs a yield tracer to account for variations in sample extraction efficiencies. Moreover, the fission track method depends upon the absolute removal of uranium from samples may be difficult to achieve. It follows that AMS has been used, successfully, to measure plutonium in a wide range of samples, including urine faeces and blood, and to measure a number of isotopes: ^{238}Pu; ^{239}Pu; ^{240}Pu; ^{241}Pu ^{242}Pu; ^{244}Pu. In addition, the number of centres undertaking AMS for plutonium is rapidly increasing. Currently, this technique is used in Australia, Austria, Germany, Israel and the United States. Nevertheless, AMS does present analytical challenges resulting from the measurement of such low levels of plutonium and further method development is indicated.

TRACKING THE BEHAVIOUR OF PLUTONIUM IN MAN

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A biokinetic model for plutonium is required both in the setting of acceptable exposure levels and in assessing occupational intakes retrospectively from quantities excreted. The model currently adopted by the International Commission on Radiological Protection (ICRP) takes into account extended literature on experiments in animals but suffers from inadequate information on the behaviour of plutonium in healthy humans. Until 10 years ago, ethically acceptable metabolic studies in man could not be contemplated. Two developments have radically altered this perspective. At Dubna, mass separation techniques have made available isotopically pure ^{237}Pu and ^{244}Pu allowing volunteers to receive these nuclides by inhalation or injection without incurring more than a trivial radiation dose. Elsewhere, advances in mass spectrometry and notably, in accelerator mass spectrometry have reduced detection limits for long-lived isotopes of plutonium in blood and excreta to the extent that useful metabolic studies can be conducted following the administration of less than 1 mBq ^{244}Pu. There have been several such studies in UK mostly with ^{237}Pu and/or ^{244}Pu provided by Dubna. Findings have included a greater uptake of plutonium by the liver than envisaged in the ICRP's model, a very low uptake by testes and the appearance of sex-related differences in excretion patterns. The data from inhalation of ^{237}Pu- and ^{244}Pu-labelled particles are being used to assess the assumption that biokinetic data from animals can be successfully extrapolated to a model aerosol behaviour in man.

INTERNATIONALLY HARMONIZED APPROACH TO BIOMONITORING TRACE ELEMENT ATMOSPHERIC DEPOSITION

A. Bleise, B. Smodis

Division of Human Health, International Atomic Energy Agency, Vienna, Austria

Air pollution is a serious problem in many parts of the world, particularly in developing countries. At present, in these countries information on levels of various airborne pollutants is very scarce. In Europe and North America, nuclear and related analytical techniques have been shown to be particularly appropriate for the analysis of air pollution biomonitors, such as moss and lichen, being multi element, reliable, extremely sensitive for many toxic elements, matrix independent and suitable for all concentration ranges.

The International Atomic Energy Agency (IAEA) has been supporting work on airborne particulate matter since 1992 through various coordinated research and technical co-operation projects. In 1997, biomonitoring air pollution using plants, became officially a part of the IAEA project on environmental pollution monitoring and research. Based on (1) positive experience in using biomonitors, especially lower plant such as mosses and lichens in several developed countries, (2) the continuous use of biomonitors in several Member States, and (3) the fact that nuclear and pollution biomonitors, such studies are now being supported by IAEA in 14 countries within a coordinated research project. The man emphasis of this project is on (1) identification of suitable biomonitors of atmospheric pollution for local and/or regional application, and (2) their validation for general environmental monitoring, whenever possible. Besides developing appropriate harmonized sampling and analytical procedures in geographically and climatically diverse parts of the world, the participants are performing statistical analysis for identifying pollution sources, and creating graphical plots showing the geographical distribution of the elements, the levels of selected environmental pollutants, and the time trends.

In all of these activities, proficiency testing and analytical quality assurance are an important issue, which merits special attention. To this end, a variety of analytical quality control materials have been used in intercomparison exercises and proficiency testing, some of them supplied as bulk material, and some of them as particulate matter deposited on filters. The lichen reference material IAEA-336 has been issued through a co-operation of the IAEA and the ITN, Portugal. Lichen collected from areas presumed to be of low contamination by trace elements was used in preparing the material, which was submitted to an international intercomparison exercise involving 42 laboratories from 26 countries. Evaluation of the data resulted in recommended values for 19 elements and information values for 14 elements. Within the scope of the NAT-5 intercomparison, two lichen materials were distributed among 16 participating laboratories and the performance of most laboratories was satisfactory.

In this presentation, an overview of these activities is given along with the details where possible.

SURVEY OF ATMOSPHERIC HEAVY METAL DEPOSITION IN EUROPE ORGANIZATION OF THE PROJECT

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Background and Description

Atmospheric Heavy Metal Deposition in Europe is the title of the monitoring project developed and carried out by the Nordic Working Group on Monitoring and Data (NMD) under the Nordic Council of Ministers. The leader of the Project is responsible for intercalibration of the laboratory analyses of heavy metals, coordination of the entire work process as well as collecting the produced data from a large number of countries, and presenting the results of heavy metal concentrations of mosses on isaritmic maps. The NMD Working Group has financed the contribution to the work of the Project Leader, as well as some sampling and laboratory work in, e.g., participating countries of the former Soviet Union and in connection with the intercalibration process. As for the rest of the work involved, it has been nationally organised, performed and financially supported by integrating into national monitoring strategies and budgets.

The concept and technique of analysing of the deposition of heavy metals in mosses (*Hylocomium splendens*, *Pleurozium schreberi*) were introduced in the Nordic countries and tested in 1980 as a joint Danish-Swedish initiative. Later – in 1985, 1990 and 1995 – there followed similar surveys of moss sampling, each time involving an increasing number of participating countries. In the years 1995–96, some 30 European countries took part in the Project (Nord 1996: 37 & 1998: 15). Countries such as Belorussia, Bulgaria and Ukraine, joined the survey thus completing the picture of heavy metal deposition in all Europe.

Administration and Economics

The 1995–96 survey was administrated by the NMD Secretariate, and final reports are published in the Nordic Council of Ministers Nord-series. The costs of coordination and quality assurance work in the laborious phase of inviting the participants, intercalibrating national laboratories, sampling mosses and humus, and assuring proper delivery of comparable data from all over Europe amounted to some 40–60.000 USD/year. In the succeeding years of final checking, producing the maps, interpreting the results and summing it all up before the next survey, the annual expenses were slightly less. The non-recurrent charge of printing final reports is in the region of 15.000 USD, depending on the number of copies.

For each participating country the cost of sampling and producing the required data will naturally vary considerably. In the past years the National Project management has, therefore, run into some difficulties particularly, in Russia and in the countries of Central Eastern Europe. Though on the whole, though, NMD funding has been able to focus on the financial support of the Project leadership.

Current status

As of August 2000, sampling or preparations for moss sampling started. In 1999 invitations were sent to previous collaborators and potential ones. We do not intend to make an intercalibration between the laboratories this time. Instead, national project leaders are asked to ensure that the analytical quality is satisfactory. For this purpose, a reference sample with a known heavy metal content will be distributed. A few control samples will also be sent to be included in the routine analytical work and reported on.

NMD is financing the initiation phase of the 2000 survey, but has not committed itself to fulfil the entire process ending around 2003–2004. The Project comprising the concept itself and performing the entire procedure is well developed, quality assured, tested over many times, and found useful for estimating heavy metal deposition and accumulation of some 10 various elements on a continental scale. Consequently, NMD considers its work done, and would preferably pass the entire concept into the hands of a respected international organization in the field of environmental monitoring.

We thus feel that the revelations and outcome of the Project are most valuable in monitoring the state of environment, finding many of causes and effects and also, in assessing the effects of protective measures. A long-range scale makes international comparisons and transboundary conclusions possible which, in turn, facilitate and intensify the efforts of finding solutions to common problems simultaneously affecting a large number of states.

For work on conventions, critical loads and corresponding international environmental agreements, the results of the Project are invaluable, looking back at past conditions in a time continuum is as important as any. We share, in a large scale, the present trend of displaying the state of environment in Europe to enhance public awareness and stress the need of data as those produced by the Project.

USE OF MOSSES AS BIOMONITORS OF HEAVY METAL DEPOSITION: FROM RELATIVE TO ABSOLUTE DEPOSITION VALUES

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Ground growing mosses have been used in Norway for the last 25 years to monitor the deposition of trace elements from the atmosphere using a variety of analytical techniques. In this paper experience from this work will be summarized, with particular emphasis on the conversion of element concentrations in moss to bulk deposition rates (1): Concentrations of 48 elements in samples of *Hylocomium splendens* and *Pleurozium schreberi* collected at 13 different sites were compared with bulk deposition data for the same elements from precipitation samplers. Significant positive correlations were found for V, Fe, Co, As, Y, Mo, Cd, Sb, Tl, Ce, Sm, Er, and Pb in *Hylocomium splendens* and for Mg, Fe, Co, As, Y, Mo, Cd, Sb, Tl and Pb in *Pleurozium schreberi.*

The regression equiation for transforming moss concentration data to absolute deposition rate has been calculated for those of above elements, which are of interest from a pollution point of view. The concentration levels of Li, Be, Mg, Ca, Zn, Ge, As, Se, Sr, Y, Zr, Sn, Cs, Ba, La, Ce, Pr, Nd, Sm, Ho, Yb, Hf, Ta and U are similar in the two moss species. *Hylocomium splendens* had higher concentrations of Cr, Fe, Co, Ni, Cu, Ga, Nb, Mo, Sb, Eu, Gd, Tb, Dy, Er, Tm, Lu, W, Tl, Pb and Th, whereas V, Mn, Rb and Cd were highest *in Pleurozium schreberi.* No variations were observed in the concentration of the studied elements during the sampling season.

(1). T.Berg and E.Steinnes, Environ. Pollut. 98 (1997) 61-71.

ATMOSPHERIC DEPOSITION OF TRACE METALS STUDIED BY MOSS AND LICHENS ANALYSIS: SOME EXAMPLES FROM RUSSIA

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Monitoring of large-scale atmospheric deposition of heavy metals with terrestrial mosses and lichens is well established in the Nordic countries and Western Europe. During the last few years it has also been applied in Eastern Europe. The authors of this paper were among the first to use it on a regional scale in Russia. The technique quantifies the atmospheric deposition of metals by using the mosses *Hylocomium splendens* and *Pleurozium schreberi* as recommended by the European Atmospheric Heavy Metal Deposition monitoring project. Applying this methodology to areas of Central and Eastern Russia yet not covered by the European moss survey will significantly broaden our understanding of air pollution in Europe. Although heavy metals in mosses can be measured by a variety of techniques, the Department of Activation Analysis and Radiation Research of FLNP JINR, Dubna, has used epithermal neutron activation at its IBR-2 reactor to determine the concentrations of nearly 40 elements in samples from remote areas as well those affected by air pollution. With support from its member-states and IAEA, JINR is currently pursuing several projects that combine moss biomonitoring with GIS technologies to construct maps of atmospheric deposition for a large suite of elements. The areas involved include the Southern Urals (Chelaybinsk Region), Tula (south of Moscow), and the watershed of the Moscow Sea, a reservoir north of Moscow that serves as its source of fresh water. As an alternative to moss, lichens, such as *Cladina* and *Cetraria* have been used in the Khibiny Mountains of the Kola Peninsula, an area that is strongly affected by industrial emissions. In each of these places, information on the nature and location of pollution sources is obtained by subjecting the elemental results to multivariate statistical analysis (factor analysis), followed by a graphical analysis of post-analytical quality control. Coloured contour maps of elemental deposition in areas of interest have also been generated by using GIS-INTEGRO with raster and vector graphics. The results of these studies are gradually building a unique database that documents the distribution of air pollution in selected areas of Russia at the beginning of the twenty-first century and serves as a starting point for the next generation of environmental researchers.

HEAVY METAL MOSS MONITORING IN INDUSTRIAL REGIONS OF POLAND

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Pleurozium schreberi (Brid): Mittl., a common moss species, and sensitive indicator for ecological monitoring, was used to estimate the atmospheric deposition of heavy metals in 2 industrial regions in southern Poland and in the north-eastern part of the country as a background area. Moss samples were collected in 1998 in Kraków-Silesia Region in 88 sites, in Legnica -Głogów Copper Basin in 63 sites and in the control area in 21 sites. The concentration of 7 heavy metals (Cd, Cr, Cu, Fe, Ni, Pb, Zn) in mosses was determined using to wet digestion method (HNO3+HClO4) and AAS Varian 20BQ.

The Kraków - Silesia Region (13608 km^2) represents approximately 4% of the country territory but there are concentrated 20% of national industrial production and about 25% of heavy metal emission in the country. The Legnica Głogów Copper Basin (4036 km^2) represents approximately 1.3% of the country and concentrates about 25% of copper emission. The control area in north-eastern Poland (21054 km^2) covers approximately 7% of the country and concentrates about 2% of heavy metal emission of the country.

In the Kraków -Silesia Region the average concentrations of heavy metals in mosses were as follows: mg/kg Cd 2.17, Cr 6.2, Cu 9.4, Fe 1226, Ni 2.51, Pb 69.4, Zn 150. In the Legnica-Głogów Copper Basin Cd 0.30, Cr 1.51, Cu 73, Fe 519, Ni 2.49, Pb 32, Zn 48, and in the control area: Cd 0.09, Cr 0.8, Cu 4.5, Fe 298, Ni 1.42, Pb 17.9 Zn 37, respectively. A comparison of the data obtained from 3 regions showed the highest concentrations of most elements in mosses in the Kraków -Silesia Region, the copper level was the highest in the Copper Basin, the north-eastern part of the country was relatively clean. The spatial differences in heavy metal levels in mosses in both industrial regions were found.

The picture of heavy metal contamination in Poland obtained using mosses corresponds to the distribution of emission sources in the late 90s. The emission in tonnes of particular heavy metals in the Kraków-Silesia Region was as follows: 17 Cd, 30 Cr, 70 Cu, 59 Ni, 275 Pb, 679 Zn, in the Legnica-Głogów Copper Basin 3 Cd, 2.5 Cr, 146 Cu, 11 Ni, 117 Pb, 236 Zn.

Using *Pleurozium schreberi* detailed local studies in the Niepołomice Forest (NF) were conducted in 1970 and 90s. The NF is situated within the Kraków-Silesia Region, 10 - 35 km to the east of Kraków agglomeration and a big metallurgical complex Nowa Huta built in 1950. The Kraków population is 800 000 and the city has several factories, power plants and a heavy vehicle traffic. The NF is a large forest complex (110 km^2). Due to the direction of prevailing winds in this region the forest is affected by pollutants emitted both by the metallurgical complex and the city. In the 70s, SO_2 emission from the Kraków agglomeration amounted to 150000 tonnes and dust emission was 170000 tonnes with large quantities of heavy metals. In the 90s the industrial production decreased, the SO_2 emission from the Kraków agglomeration amounted to 83000 tonnes and dust, emission was 67000 tonnes. Moss samples were collected in 1975 (15 sites) and in 1998 (78 sites incl. the 1975's 15 sites). Both time and space differences is heavy metal patterns in the NF were found. The highest concentrations of metals were observed in 1975. A decrease in element concentrations in moss in the NF between 1975 and 1998 was very distinct and it corresponded to a decrease in heavy metal emission in the same period. The highest concentration of metals occured in the western part of the forest complex which is the closest to the sources of dust emission. As compared to moss from a forest located in the centre of heavy industry in Silesia the NF is less contaminated by heavy metals and particular, by Cd, Pb and Zn. As compared to heavy metal concentrations in mosses from clean areas of Poland, the concentration in mosses from the NF is three times as high, of Fe, Cu, and Zn are twice as high and that of Cd is seven times as high. The level of heavy metal contamination of the environment of the NF corresponded well with the level of emission in the 70s and 90s.

Despite of many limitations caused by abiotic and biotic factors the moss technique to estimate the heavy metal burden in the environment is still one of the best methods, available.

The study was supported by the Polish Research Committee (grant no. 6 P04F02315p02).

THE USE OF LICHENS AND MOSSES TO MONITOR TRACE ELEMENT AND RADIONUCLIDE POLLUTION IN SLOVENIA

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Two national surveys using biomonitors to monitor atmospheric trace element and radionuclide deposition have been performed in Slovenia. Namely in 1992, the epiphytic lichen *Hypogymnia physodes* was collected at 86 sampling points of the regular bioindication grid and in 1995 moss samples (*Pleurozium schreberi and Hypnum cupressiforme*) were sampled at 33 selected locations of the same bioindication grid as a part of the international project known as Atmopheric Heavy Metal Deposition in Europe.

The K_0-based instrumental neutron activation analysis (k_0-INAA) was mainly used for the determination of more than 40 elements in these biomonitors while direct gamma-spectrometry of lyophilised samples was applied to obtain information about the levels of natural (^{210}Pb, ^{40}K) as well as artificial radionuclides (^{137}Cs).

Higher average values of so-called soil elements were found in mosses; however, after normalisation of the original concentration levels in both organisms to Sc, better agreement between moss and lichen results was found. Through the graphical presentation of the results it was evident that both surveys give similar distribution patterns of elements in the territory of Slovenia.

MOSS TRANSPLANTING TECHNIQUE USED TO STUDY HEAVY METAL ATMOSPHERIC DEPOSITION IN CHINA

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China is a developing country facing serious environmental problems with its fast increasing. Biomonitoring survey using lichen and moss technique has started since late 1998 within the capital region and other areas around China. According to the new annual reports from Institute of Microbiology and Institute of Botany, CAS, there are more than 2000 species (in 260 genera) of lichens and 2100 species of mosses (in 490 genera) spreading across China. It gives us a vast occasion for the optimization of lichens and mosses as suitable biomonitors.

The main results of our present study are as following:

(1) The distribution of lichens and mosses has been investigated and sampled in the Beijing Area (one of the most populated regions in China) while comparing with other several nation's natural reserves in the southeast and outlying area of China

(2) The alternative species of large size epiphytic foliose or fruticose lichens and feather mosses were optimized by interspecies comparisons of trace element concentrations in the selected organisms

(3) Analytical methods for the determination of more than 45 trace elements in lichens and mosses have established by instrumental neutron activation analyses (INAA), inductively coupled plasma mass spectrometry (ICP-MS), atomic absorption spectrometry (AAS) and hydride-generation atomic fluorescence spectrometry (HGAFS)

(4) Environmental status of heavy metal atmospheric deposition from 60's to 90's in southwest part of China has been retrospective evaluated by survey of epiphytic lichens stored in State Lichen Bank

(5) Transplanted mosses as biomonitors of heavy metals were exposed in the vicinity of a highly polluted industrial city with steelworks and a rare-earth elements mineral ore in Inner Mongolia. The amount of accumulated metal concentrations of the transplants has been applied to the explanation of the metal content of the fallout from the air influenced by the local pollutant emission.

More conclusions and details of the recently research results will be discussed and presented.

MAN-MADE PLUTONIUM IN ENVIRONMENT – POSSIBLE HAZARD FOR HUMAN HEALTH

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It is pointed out that, contrary to the situation with natural Rn, the growing concentration of man-made Pu in environment – natural water, soil, plants and food – can provide the serious danger for all kind of animals and especially for mankind. Really, as it was established recently, element Pu is accumulated in human body during all the life and the dangerous concentration estimated to be about 10^{-12} gram Pu per gram of human tissues. Unfortunately up to now there are no simple nonexpensive methods of Pu determination at the level of sensitivity 10^{-14} – 10^{15} g/g which can provide the determination of Pu even in 0.1 g of human tissue. We warn that now the average concentration of Pu in human body is not less than 10^{-14} g/g and much higher for some «hot» regions in Europe and Asia. We propose to discuss the problem of organizing world net exploration of Pu in environment – similarly to Rn exploration program – and personnel Pu monitoring for inhabitants of Pu damaged regions. Our approach to the problem is based on chemical separation of Pu, on determination of Plutonium by high fission cross section with thermal neutrons ^{239}Pu (n, f) reaction and by control of possible admixture of ^{235}U isotope by ^{238}U (γ, f) reaction in Pu preparations. Such a procedure provides the level of sensitivity up to 10^{-13} g/g of Pu for solid samples in our initial studies.

To improve the sensitivity of the method of Pu determination in specimens we applied two additional steps of chemical separation of Pu from U. After the usual chemical separation of Pu we used second step with ion-exchange column, where the ions of U^{4+} were capture by sorbent and Pu^{3+} ions remains in solution. For converting Plutonium to Pu^{3+} state the electrochemical procedure has been used. After the electrochemical separation procedure the solution was deposited onto quartz glass. Then the quartz glass plates were inserted into the gas mixture flow ($SOCl_2$+AIR) at the temperature 650°C. Such a procedure extract ≥90% U from Pu layer. Now we provide the chemical separation of Pu from U by a factor $\geq 10^7$. It means that we are able to perform the routine Pu analysis at the level of sensitivity 10^{-14} – 10^{-15} g/g.

The new technique could be used in routine analysis of Pu in population of heavily damaged regions (Chernobyl, Ural Region, Semipalatinsk).

ON DETERMINATION OF MAN-MADE TRANSURANIUM ELEMENTS IN ENVIRONMENT SAMPLES (AIR, WATER, SOIL)

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DETERMINATION OF ACTINIDES IN BIOLOGICAL SAMPLES IN BELARUS

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The appearance of artificially created toxic actinides in the biosphere is a relatively new problem in the analytics of the environment. Their behaviour (migration and accumulation) in the objects of the environment has been studied insufficiently. In this connection it is difficult to estimate the effect of actinides on the health of a human being. Since the accident at the Chernobyl Nuclear Power Plant (NPP) this problem has become very important. The alpha-emitting nuclides of actinides are most dangerous due to a high qualitative factor of alpha-irradiation and their long half-lives. Alpha-emitters are not spread homogeneously in the biosphere, but they can be partially accumulated in aerosol «hot» particles or in microvolumes of tissues.

Fast, high-sensitive and cost-effective methods were developed and applied for the determination of the content and microdistribution of actinides in different biological samples (thyroid, hair, etc.). The developed techniques based on nuclear track radiography permit the measurement of alpha-activity on the level of about 10^{-6} Bq/sample and detection of the microdistribution of TUE in samples with a spatial resolution of 5μm.

The obtained results show, that local irradiation doses in the microvolumes of thyroids of the inhabitants of the Gomel region exceed the irradiation doses radionuclides in the whole thyroid for their uniform distribution by an order of 3-4. The content of Pu-239 in hair of the inhabitants of the Gomel region (5 - 16 Bq/kg) is higher than in hair of the inhabitants of clean areas (1.5 - 3.7 Bq/kg).

The obtained results are of great interest for the forecast of pollution and the bringing to light of risks to the health of population.

THE USE OF NUCLEAR TRACK TECHNIQUE IN ENVIRONMENTAL INVESTIGATIONS

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When an energetic and electrically charged particle (ion) enters an insulating solid material like an inorganic crystal or a polymer foil, a permanent change (damage trail) along its path occurs. A latent track is formed which can be enlarged with a suitable chemical etching reagent and thereby made observable with a microscope.

Two categories of application of this nuclear track technique are of interest here:

The use as detector (Solid State Nuclear Track Detector, SSNTD) for charged particles (e.g., alpha-particles, fission fragments), but also for neutrons that have to be converted first into charged particles by nuclear reactions.
For example, SSNTD's are in use to discover hazardous alpha-sources (e.g., by means of radiographic techniques), neutron and radon measurements can be performed.

Nuclear track micro filters (NTMF) are produced when the charged particle penetrates the material completely. The material has to be chosen according to the intended use of the NTMF. Filter thickness, hole size and porosity can be varied. Such filters exhibit outstanding properties with regard to thermal, chemical and radiation resistance. Their surfaces are smooth and optically clean.
For analytical purposes, filtration of liquids and aerosol sampling are possible. The filter load can be investigated with various techniques. For example, direct measurement of alpha-radiation by surface barrier detectors (where it is easy to produce thin sources), observation of collected alpha-emitters by autoradiography, study of size, shape and elemental composition of collected particles by means of a scanning electron microscope with attached energy dispersive X-ray analysis (EDXA) equipment. The optical properties of the filter surface allows the use of image analyzing systems.

The part of this contribution dealing with SSNTD's should be understood as an introduction to the contributions to be given by specialists in their respective fields.

ACCELERATOR BASED RADIOANALYTICAL METHODS FOR THE ANALYSIS OF ENVIRONMENTAL SAMPLES

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Accelerator based radio analytical methods, such as charge-particle activation analysis (CPAA), fast neutron activation analysis and particle induced x-ray emission analysis (PIXE) for the analysis of different elements especially, heavy elements in environmental samples are described and their strengths and limitations are discussed.

A simple method (**Chaudhri's Method**) for charge-particle activation analysis is presented which is simple, accurate and reduces the CPAA to the simplicity of the neutron activation analysis. Extensive calculations are carried out to provide further evidence for the accuracy of the method. By making use of this technique the effects of French Atomic Tests Series of the 1970's on the Australian Atmosphere were investigated.

Detection sensitivities of most elements with Z between 20 and 92, in different matrices through activation with protons, deuterons and alphas of up to 35 MeV have been calculated and the results are presented in the graphical form.

The detection sensitivity of any element in this range, for a thick, moderately thick or a thin target can be directly read from the curves under known irradiating conditions. Furthermore, an estimate of unwanted and interfering activities being produced simultaneously can also be made from these «activation curves».

A simple method for estimating the detection sensitivities of different elements through activation with fast neutrons produced by accelerators of different sizes is presented and its application is demonstrated for a few cases.

Some examples are presented where the powerful technique of PIXE has been applied to analyse heavy metals in environmental samples. Special advantages of this very simple technique for the analysis of environmental samples, along with its limitations, are critically discussed.

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METHODS OF HIGH-SENSITIVE ANALYSIS OF ACTINIDES IN LIQUID RADIOACTIVE WASTE

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A complex of methods has been developed to determine actinides in water coolants and liquid radioactive waste (LRW) for solving the problems of radiation, nuclear and ecological safety of nuclear power and research reactors both operating and being decommissioned.

The method of determination of actinides in liquid and solid media, including the LRW of high mineral content and bottom sediments of LRW storage pools is based on the radiochemical separation of U, Np - Pu, Am - Cm on ion - exchange and extraction columns. An identification of radionuclides and determination of their content are performed using alpha - spectrometry. The targets for the alpha - spectrometry are prepared by electrolytical precipitation of actinides onto polished steel disks.

A radiochemical process, electrolytical precipitation, a semiconductor detector of alpha particles A300-17 AM and soft wear Genie-PC (detector and soft wear, Canberra Industries, Inc., USA) provide the energy resolution of (17 to 25) keV and a reliable identification of the nuclides: U-232, 233, 234, 235, 236, 238; Np-237; Pu-236, 238, 239+240, 242; Am-241, 243; Cm-242, 243, 244. A detection limit for actinides activity is 0.04 Bq in a sample. The radiochemical output was (0.5±0.1) for U and (0.8±0.1) for Pu; for Am and Cm it was (1.00±0.05). The alpha-spectrometer and the measurement methodology are certified. The microconcentrations of the sum of the main fissile materials U-235 and Pu-239 are determined using plastic track detectors based on polyethyleneterephthalate. Track detectors, placed directly into a liquid sample, are irradiated by thermal neutrons to a fluence of ($2 \cdot 10^{14}$ to $1 \cdot 10^{16}$) cm^{-2} and then etched electrochemically. The detection limit for U-235 and Pu-239 is $3 \cdot 10^{-12}$ g/cm^3. An independent method of U-238 content determination is the neutron activation analysis, where gamma-quanta of the energies 103 and 106 keV of the nuclide Np-239 are registered. The Am-241 content is possible to determine with gamma-spectrometry (E_γ = 59.5 keV). The energy resolution of the germanium detector in this energy range is 1.0 keV (the detector is of the type GC1019, Canberra Industries, Inc., USA).

The chemical content of macrocomponents is determined by various methods including the atomic-absorption spectrophotometry (the spectrophotometer is Buck 210VGP, Buck Scientific, USA).

These methods are used to control the radiation safety of the primary circuit of the operating water - cooled water - moderated research reactor IVV-2M. Also, they allow one to draw conclusions about the nuclear safety of coolants and bottom sediments in spent fuel storage pools and in LRW of the storage places of the reactors AMB-100 and AMB-200 being under decommissioning at the Beloyarsk NPP.

The developed methods are quite universal and applicable for solving the problems of environmental monitoring.

CONTAMINATION OF THE BELARUS TERRITORY BY TRANSURANIUM ELEMENTS

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The territory of the Republic of Belarus underwent anthropogenic pollution with transuranium elements from two sources : firstly, global fall-out after nuclear weapon tests and secondly, the fall-out as a result of the Chernobyl NPP accident. The levels of radioactive contamination with transuranium elements on the territory of Belarus as a result of nuclear weapon tests and the Chernobyl NPP accident have been assessed for 17 actinides. A uniform contamination of soil with a level of 53±17 Bq/m^2 for $^{239+240}$Pu was formed as a result of global precipitation after nuclear weapon tests. This value increased up to 1.1 × 10^5 Bq/m^2 in the South regions of Belarus and gradually decreased to the level of global fall-out in the North of the Republic after the Chernobyl NPP accident. The radioactive contamination of the territory of the Republic of Belarus with transuranium elements due to nuclear weapon tests is distinguished by the lower ratio of ^{238}Pu/ $^{239+240}$ Pu activities: 0.034±0.006 and ^{241}Pu/ $^{239+240}$ Pu - 4.3±0.8, 0.41 as compared to the same ratios of activities of plutonium isotopes of Chernobyl origin which constitute 0.41± 0.02 and 87.0±11.0. In the active stage of the Chernobyl NPP accident, the pollution of the main components of the biosphere was determined by short-living actinides, ^{239}Np and^{242}Cm. Their contents were higher than the $^{239+240}$ Pu activity 5.6×10^5 and 40 times, respectively. In the global fall–out, these transuranium elements were practically absent. The constants growth of ^{241}Am contents in all components of the Belarus ecosystem is observed as a result of the radioactive decay of ^{241}Pu . The maximum level of pollution with ^{241}Am will be reached in 2060 and will exceed that of $^{239+240}$Pu 2.7 times. In our estimation, the areas with a density of surface pollution of soil of $^{238+239+240}$Pu + ^{241}Am up to 3.7kBq/m2 will expand outside the limits of alienation zone in the west and north-west direction at 20-30 km.

The study of the atmosphere contamination with TUE in the Republic of Belarus has been held since 1980 to present. A gradual decrease of TUE content in the surface air to 3.2 nBq/m^3 in April 1986 as to $^{239+240}$ Pu is observed. In period of the Chernobyl NPP accident (end of April - beginning of May, 1986) the $^{239+240}$ Pu content reached a value of 120 μBq/ m^3 in the North part of Belarus. The period of half-removal of plutonium from nuclear weapon tests and of Chernobyl origin from the atmosphere according to the observation period is the same and constitutes 14±2 months. The mechanism of radioactive air pollution from April, 1986 is determined by dust transfer from radioactive contaminated regions. The value of this transfer is influenced considerably by agricultural activities on the contaminated territory, forest fires and other antropogenic factors.

A characteristic peculiarity of the Chernobyl NPP accident is the injection of small dispersed fuel particles containing TUE to the biosphere.

The transfer coefficients in the soil-plant system vary from 7.1×10^{-6} to 4.0×10^{-3} for $^{239+240}$ Pu and 1.2×10^{-5} to 1.4×10^{-2} for ^{241}Am and have plant-dependent patterns.

The value of transfer coefficients of «Chernobyl» transuranium elements from soil to plants is within the limits determined for «bomb» transuranium elements. The transfer coefficients from soil to plant of ^{241}Am are higher than those for plutonium because americium is more soluble. It is necessary to note that transuranium elements are presently transported to the plant via its root system.

The specific activity in waters of most radioactively polluted Belarus lakes reaches 0.98 Bq/m^3 for $^{239+240}$Pu and 11 Bq/m^3 for ^{241}Am. The main forms of plutonium in water are colloidal particles with adsorbed Pu(IV) and complex compounds of Pu (V) and Pu(VI).

The concentration of $^{239+240}$Pu and ^{241}Am in wild animal bodies is 3.1±1.4 mBq/kg and 1.2±0.4 mBq/kg for global fall-out, and reaches 1.20 Bq/kg for $^{239+240}$Pu and 2.7 Bq/kg for ^{241}Am for some «hot» regions in Belarus after the Chernobyl NPP accident.

MONITORING AND MANAGEMENT OF MOUNTAIN ENVIRONMENT

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Mountain ecosystems are especially interesting objects for studying the influence of different natural and antropogenic factors. These ecosystems have high sensitivity and a very slow and difficult recovery which provides a real possibility for their precise studies. Complex monitoring of the mountain environment gives necessary information for its control and effective management in view of its sustainable developement. Taking into account the actuality and the importance of these problems a Frech-Bulgarian OM2 project was carried out in the Rila national park in 1993-1998. A system of complex monitoring of the environment has been established including physical, chemical, meterological, hydrological, biological and sociological factors. Methods and observations have been developed and applied. Using a geographical information system a database was created for Rila mountain and a modern computer network connected to INTERNET was established. As a direct consequence of the OM2 project a basic enviromental observatory (on peak Moussala 92925m) was constructed in attemt to control the larg scale and long term transportation of atmospheric pollutants.

HEAVY METALS IN LAKE BAIKAL ECOSYSTEMS

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Lake Baikal is unique in its physical, chemical and biological parameters, has a rift genesis and, therefore, is located in a rich geochemical province. The basin of Lake Baikal is located in the Republic Buryatiya, Irkutsk and Chita regions. The basin of the Lake represents a complex of various deposits: gold, uranium and some other heavy metals.

The Lake saves its own physical characteristics due to most effective self-purification processes and a rather low anthropogenic load. Nevertheless, permanent monitoring of prevailing pollutants is necessary in the objects of Baikal ecosystems.

At present, the data about background contents of trace elements, including heavy metals, in various environments of the Lake are scarce and are not systematical. For many years the authors of this report have studied the background and anthropogenic levels of heavy metals in various areas of Lake Baikal and its basin. Some trace elements, owing to very low levels, require the usage of most responsive methods of analysis and consequently, the monitoring of trace elements was fulfilled by various corpuscular methods.

The results of analysis of Lake Baikal and its main inflow - the Selenga river water, sediments ant water organisms, are represented in this report . The air pollution, for the estimation of anthropogenic influence in the region, was also studied by the analysis of snow, mosses and lichens.

In the report it is shown, that despite of remoteness of Lake Baikal from high industrial centres of Russia, the water and terraneous ecosystems of the Lake experience the impact of the anthropogenic effect and the effect of global migration of pollutants, including heavy metals.

NAA ANALYSIS OF SURFICIAL SEDIMENTS FROM THE SOUTH-WEST PART OF THE BLACK SEA

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Surface sediment samples collected from 7 sites of the south west part of the Black Sea around Istanbul in 1996 and 1999 have been investigated by thr Neutron Activation Analysis. The investigated samples were taken from the uppermost part of the collected specimens at each site, with spatulas and deposited into plastic bags. The samples were dried at 40 degrees Celcius before being analysed. The neutron activation analysis and activation autoradiography were used for the investigation of the impurity content and impurity distribution of the samples. The analytical results indicated that the samples contain Na, Ca, Sc, Ti, Cr, Mn, Fe, Co, Ni, Cu, As, Se, Br, Sr, Zr, Mo, Ag, Cd, Sb, Cs, Ba, La, Ce, Sm, Hf, Ta, W, Au, Hg, Th, and U in different amounts. The results are compared with those for other marine sediment samples. This study was supported by NATO Grant EST.CLG 975645

Isotopic composition of uranium in the products of accidental ejection from the Chernobyl NPP

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The particles of fragmented nuclear fuel containing uranium of different degree of oxidation were found in 1986-1987 as the parts of conglomerates in the premises of the IV unit and in soils of the Chernobyl NPP Industrial site. When leaching uranium from contaminated soils in the first years after the accident, some enrichment of the liquid phase by isotope of ^{235}U up to 5-17% was detected. It was independently registered at three institutions of the Soviet Union.

Mass-spectrometric analysis, preceded by procedures of fine chemical purification of uranium was used for determination of the uranium isotope composition in water phase.

When repeating the experiments on uranium leaching from dispersed fuel 5 and 12 years after the accident, in water phase there was not detected any enrichment of uranium by the isotope of ^{235}U more than 1.1%, i.e. more than mean value for the fuel at the moment of Chernobyl accident. Only in the experiments of sequential leaching of uranium from rather large-sized fuel fragment the slight enrichment by the isotope of ^{235}U relative to mean uranium isotope composition in the particle was detected in the first two fractions of water leachates.

Accordingly to suggested hypothesis, fractionation of uranium nuclides of irradiated fuel between solid and liquid phases is due to differences in the energies of bonding of nuclides of ^{235}U and ^{238}U in the crystalline lattice of irradiated fuel that is leveling with time.

TRACE ELEMENT ANALYSIS OF ACTINIDES IN NATURAL WATERS AND SOIL USING (γ, F) REACTION

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The presence of actinides, and first of all their long-lived isotopes, at significant concentrations in ecosystems presents a major health hazard. It explains the attention which is given to their determination in environmental objects.

The present report deals with the determination of thorium, uranium, plutonium, and neptunium concentrations by the track method using the (γ, f) reaction.

A new highly sensitive track method of thorium (^{232}Th) and neptunium (^{237}Np) determination has been developed.

The detection limits are equivalent up to $1 \cdot 10^{-13}$ g of ^{232}Th and $3 \cdot 10^{-14}$ g of ^{237}Np. The obtained results make it possible to estimate the detection limits of ^{238}U and ^{239}Pu which equal $5 \cdot 10^{-14}$ g and $2 \cdot 10^{-14}$ g, respectively.

The method was applied to conduct ^{232}Th, ^{238}U, $^{239, 240}$Pu and ^{237}Np determinations in water and soil samples and included the radio-analytical separation procedure of the nuclides with the irradiation of resultant samples by photons from the MT-25 microtron. The fission fragments produced by photons were recorded with a 170 μm lexan foil detector.

^{234}Th, ^{237}U, ^{235}Np and ^{236}Pu were used as tracers. The chemical yield of Th, U, Np and Pu was equal to 90 %, 90 %, 75 % and 86 % for water samples and 50-70 % for soil samples.

The method allows work with small amounts of the analyzed substance, which facilitates the realization of chemical operations of separation and isolation of elements, to investigate their behaviour in the environmental and biological objects at a more lower detection limit.

The development of the method is connected with the research of SSNTD on the basis of other polymers (with the content of uranium $< 10^{-14}$ g/g), which compare favourably with lexan in radiation and chemical resistance. This will allow the use of more intense photon fluxes or an increase of the irradiation time and as a result, reaching of the detection limits for actinides an order of magnitude less than it is obtained in the present work.

DETERMINATION OF RADIONUCLIDES, TOXIC HEAVY METALS AND TRACE ELEMENTS IN ENVIRONMENTAL SAMPLES

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The present report outlines the activities in Environmental studies at Nuclear Research Center, National University of Mongolia, Ulaanbaatar. The Nuclear and Related Analytical Techniques developed in this center played a very important role in Environmental studies due to several advantageous features, such as multielemental, accuracy and low detection limits of these methods. The most appreciated advantage of Gamma Spectrometric, HP Ge detector, and Total Reflection X-Ray Fluorescence Techniques are briefly reviewed and the results of determination of toxic heavy metals, trace, natural and man-made radioactive elements in aerosols, soil, water, food, and hair samples are discussed in detail. Also, this report gives some results of natural radioactive measurements of soil, building materials and indoor radon data in the Erdenet and Ulaanbaatar cities. In some soil samples of western Mongolia there was observed the man-made radioisotope Cs-137 14.7-64.8 Bk/kg. It means that western Mongolia was exposed to ground and air nuclear explosions at Semipalatinsk (Russia) and Lobnor (China). The results of toxic heavy metals and trace elements monitoring analysis in the water of rivers, lake basins, and the river Selenge are presented.

DEVELOPMENT OF SIMULTANEOUS RADON AND GAMMA MEASUREMENTS TO CARRY OUT MONITORING IN THE ENVIRONMENT - APPLICATIONS TO SURVEY NUCLEAR WASTE STORAGES

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Some years ago different industrial activities in Western and Eastern Europe produced wastes from radioactive natural elements that were stored near the place of production in uninhabitable areas. Mining, processing and manufacturing often produced hazardous wastes the management of whose was poorly performed. They have many instances, including in recent times, of wastes that were irresponsibly dumped, leading to contaminated sites, and of materials that should not have been used. Now, for economic reasons particularly in different eastern countries, some sites with natural radioactive wastes (uranium 238, radium 226 and daughters) are left without true management.

Thus, according to their chemical nature, their type of confinement and also the evolution of the ecosystems where they are localised, part of these radioactive elements can migrate. In this case, they can become a health hazard for the population. They may arrive, before population defending ways are used: - via dissolution in the local hydraulic system or - by direct (wind, attachment on aerosol,....) and - indirect (wild fruits, cultures,...) transfers. Moreover, in all cases such contaminated sites are high sources of radon and represent a very important sanitary risk.

We have developed different techniques and methodologies to take into consideration the potential risk of these wastes. Thus we performed, with a special emphasis thinks on radon, the evaluation of risks to population of wastes at the storage site (source term) and as a result of their migration into the Environment.

To perform our investigations, we have been developing complementary techniques in the detection of radon and its decay products (silicon detector and solid state nuclear track detectors) and in the detection of gamma emitters (thermo luminescent detector). A methodology has been developed to analyse the radon concentration and gamma pollutants in large and varied areas. This analysis is effected in time or space. Thus, the measurements reveal the distribution of radioactivity and the range of variation. Moreover the instrumentation with passive detectors allows us to study the migration of radioactive elements (alpha and gamma) in situ. Also the technologies used have a low cost.

First, the instrumentation was validated in the laboratory to qualify precisely its response and then, we performed a survey of different sites in Europe.

1-MIN-VARIATIONS OF SOME NATURAL ELEMENTS IN THE BLACK SEA ZONE

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A many-year research of radon in soil and air, gamma-background in different intervals of γ-rays, temperature in soil and air and cosmic rays in the gallery near the Black Sea is conducted. Moreover, radon measuring in Temruk, Anape, Abrau-Durso began. The data are written to the memory every 5 min.

In the settlement Jankhot (by the Black Sea, near Gelendgik) a new Rn- site is created. The temperature and hydrogen concentrations in soil at the depth 1 m. were measured simultaneously. In Jankhot the data were written to the memory every 1 min. The obtained data are described. They may be used for high Sun-Lunar tides, to predict earthquakes and conduct gravitation research.

ABOUT A COMPLEX METHOD OF OBSERVATION AT THE RN, H_2, HE, NE, ORGANIC GASES AND HEAVY ELEMENTS FROM AEROSOLS IN ORDER TO PREDICT THE EARTHQUAKES

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The method of complex analysis of the components contained in depth gases has been created. Every 24 hours equal volumes of gases are gathered via filter in the space of the entering system of the mass-spectrometer where cryogenic depletion of gas into its components takes place. Quantitative determination of H_2, He, Ne left in the volume is carried out by the mass-spectrometer working in the static regime. The determination of α-activity of Rn s decay products in aerosols gathered on the filter is carried out by the photomultiplier during the elemental analysis - by a Mattauch - Herzog - type mass spectrometer with a laser-ion source. The determination of organic gas compounds existing in the same volume is made by the chromatograph.

The dynamics of concentration changes of the components during the period before the earthquake may show the effectiveness of each method. Simultaneous parallel changes of several methods give the opportunity to reveal the abilities of each method. In future, we intend to carry out systematical measurements of the D/H, $^3He/^4He$, $^{13}C/^{12}C$ isotope ratios. The laboratory has got some definite traditions to determine the mentioned ratios.

The method may, of course, be used for the investigation of other problems, including, e.g. a search for hydrocarbons.

RADIONUCLIDES IN BONES OF WILD, HERBIVOROUS ANIMALS FROM NORTH-EASTERN POLAND

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The isotopic composition observed in environmental samples from farth northeastern Poland in the result of a quasi-continuous fallout of a number of small «hot particles«. An interesting question is if long lived non-volatile radionuclides from «hot particles» are now bioavailable. Our team conducted a project on the accumulation of plutonium, americium, curium, europium radioisotopes and the ^{90}Sr in bones of wild herbiovorous animals during last the three years. Thirty-nine samples of bone from the front leg of deer (*Cervus elaphus*), roe-deer (*Capreolus capreolus*), boar (*Sus scrofa*) and elk (*Alces alces*) were obtained during the winter of 1997/98 from hunts organised in north-eastern Poland, and some additional samples were obtained a year later in south-central Poland. In the article we intend to present yet unpublished results and summarise the whole project.

Dried, grounded and mechanically cleaned from soft tissues animal bones were measured for the presence of gamma emitters. Then radiochemical procedures were applied to measure selected alpha (i.e. Pu, Am, Th isotopes) and beta emitters (^{90}Sr, ^{241}Pu). The matrix composition of samples was determined mainly by means of the PIXE method. A gamma spectrum of all alpha-sources together prepared from rare-earth fractions of the samples was taken to detect any possible traces of europium isotopes (or other rare-earth gamma-emitter) – without success. Traces of ^{137}Cs were found in each sample, for roe deer sometimes exceeding 10 Bq/kg (dry weight). Radium isotopes (^{226}Ra and ^{228}Ra) were present on the level of single Bq/kg. A little higher were the activities of another natural nuclide, ^{40}K. On average, it was almost the same for all examined species. The activity of ^{90}Sr dominates over all others, being almost two orders of magnitude higher than the activity of radium or cesium isotopes. Cosmogenic ^{22}Na was present in the samples on the level below 1 Bq/kg. Possible traces of $^{239+240}Pu$ were seen only in four samples of which it was above the 3σ background for just one sample. The results for ^{241}Pu obtained for grouped samples are on the level of several hundred mBq/kg for ash bone, namely from 140±40 mBq/kg for the roe deer set to 400±80 mBq/kg for one of deer set. For ^{90}Sr, ^{226}Ra, ^{228}Ra and especially for ^{228}Th, the average activities for species are similar or comparable for three species (deer, roe deer and elk) but for boar they were lower. On the contrary, for ^{137}Cs, the highest activities were for boar samples. This reflects most likely the differences in feeding habits. Animal bones from northeastern Poland showed about twice higher concentrations of ^{90}Sr compared to those from south central Poland. The observed activities support the previously obtained results which suggested a deposition of Chernobyl-origin ^{90}Sr in northeastern Poland from 1.9 kBq/m^2 to 3.5 kBq/m^2 in 1986. The results suggest that the ratio between $^{239+240}Pu$ and ^{90}Sr for transfer factors from soil to bones is on the level of 10^{-3}. No correlation was found between the activities of any radionuclides except for a rather obvious correlation between ^{228}Ra and its daughter, ^{228}Th (Pearson's correlation factor $r^2=0.46$, significant level $p<0.0001$).

Of all the non-volatile radionuclides from „hot particles» only ^{90}Sr seems to be effectively transported through the food chain to the animal bone. The effectiveness of transport for $^{239+240}Pu$ seems to be lower by a factor of 10^{-3}. Americium or europium seems to be transported not more effectively than Pu.

The Polish State Committee for Scientific Research (KBN) is warmly acknowledged for the support of this project (grant No 6 P04G 09014).

THE POLLUTION OF THE ENVIRONMENT CAUSED BY LEAD DUMPING AFTER THE CHERNOBYL NPP ACCIDENT – MYTH OR REALITY?

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During the lead dumping operation at Chernobyl nuclear plant 40 t boroncarbid, 800 t dolomite, 1780 t sand and loam as well as 2400 t lead were thrown down at the reactor. Considering that the temperature in the reactor core was between 1800 to 5000°C, it can be assumed that a significant part of lead might have come in contact with such high temperatures in the zone of influence of the reactor. As a result, it might have been evaporated and set free as an aerosol polluting the environment.

Using the phytogeochemical indication method, possible pollution of the natural landscape was studied within a 30km zone between the borders of Kiev Polessje and Chernigiw Polessje as well at larger distances of up to 60 km from the reactor. Building of a net for sampling was also considered to determine the deposition of lead in soils. This was to determine worked out by geological search experts from Kiev. The deposition of lead was studied in plants accumulators (5 species of lichens, 4 species of mosses, tree bark and pine needles after abscission). The deposition of lead in plants was investigated with the atomic absorption analysis method AAS-1N (Germany). Wet ashing, using nitric acid was used.

It is found that the concentration of lead in lichens and mosses collected in the sources, apart from industrial pollution, were within the background deposition range. So, the content of lead in lichen amounted to 3.3 μg/g – 13.3 μg/g and in mosses it was 6.6 μg/g – 15.4 μg/g. This data corresponds to the background deposition of lead indicated for different regions in Europe and North America. According to our data, (Blum, Tjutjunnik, 1995) the background deposition of lead in *Hypogymnia physodes* in the region of Kiev in 1984 (before the Chernobyl accident) amounted, on average, to 3.6μg/g - 9.9μg/g.

The collected data indicating a low lead deposition level in the aforementioned plant-accumulators proove that no lead pollution has taken place as a consequence of lead dumping in the examined territory. The opinion about a low background lead deposition has also made other researchers (Van den Berg at al. 1992) carry out studies in lead concentrations in the lichen *Parmelia sulcata.* As indicators of pollution of natural landscapes by stable radioactive elements, the following lichens found in the Chernobyl zone could be recommended in a preferential order. They are the epiphytic species,such as *Hypogymnia physodes, Parmelia sulcata* and *P. acetabulum*, the epigeic lichen *Cladina mitis,* and of mosses – the soil-dwelling *Pleurozium schreberi,* as well as *Dicranum scoparium.*

DESTRUCTION OF FUEL PARTICLES OF THE CHERNOBYL FALL-OUT ON THE BELARUS TERRITORY

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A characteristic feature of the Chernobyl accident is the intake of finely dispersed fuel particles into the biosphere, where content is fission products and actinides with a high specific activity. The transfer rate of radionuclides (Sr, Pu, Am and others) capsulated in fuel particles into a mobile state and their involving into biological cycles is determined by the destruction rate of fuel particles which differs as to the content and conditions of their formation. Large non-oxidized fuel particles with a UO_2 matrix fallen out as a result of the initial explosion of the Chernobyl NPP formed the contamination of the territory in a direct proximity of the reactor, the so-called narrow western trail. The contamination of more remote regions (a northern trail) is determined by dispersed fuel particles in the oxidized form (UO_2 + U_3O_8) formed in the burning of the reactor.

In order to forecast the behavior of radioactive fall-outs in the zone of the Chernobyl NPP the destruction rate of fuel particles and leaching of radionuclides from them under various soil conditions were studied. For this, leaching of Pu via carbonate solution from soils in the western and northern trails without dissolving of the non-oxidized matrix of UO_2 was used. Owing to the fact that Pu is uniformly distributed in a fuel particle and is isomorphic to uranium, the portion Plutonium transferred to the solution must correspond to the portion of oxidized fuel particles.

At present, the portion of oxidized fuel particles is estimated by some authors using Strontium-90 extracted 2 mol/l NH_4Ac. The values of the constants of fuel particles transformation at separate experimental sites obtained here vary in wide ranges (10^{-9}-10^{-8}) and cannot be used for calculations in other soil and climatic conditions because the interaction forms (exchangeable, non-exchangeable) and sorption strength of Strontium-90 in soil components are not taken into account as well as the presence in soil of Strontium-90 of condensation origin.

The upper layers (up to 20cm) of two types of soil, such as podzol and peat, with high levels of contamination with fuel (western trail) and mainly fuel components (northern trail) have been used as objects for investigation.

A comparison of the results of carbonate leaching of Plutonium and leaching of Strontium-90 by ammonia acetate has been carried out. It is shown that the portion of oxidized fuel particles for selected points as to western trail constitutes 65-70% as to Plutonium and, 55-60% as to Strontium-90. For samples from the northern trail as to Plutonium - 70-75% the dependence on the soil type is observed; a wide spread in values, 5-50%, is observed when determining using Strontium-90. The dissolving rate of the oxidized layer of fuel particles in different radioactive trails has been determined. The difference in the chemical stability of fuel particles is connected with different in temperature conditions of formation and dispersed content of particles in the nearest and remote areas from the reactor.

STUDIES OF SELENIUM AND SELENOPROTEINS IN FOODS BY NEUTRON ACTIVATION ANALYSIS

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The biological essentiality of Se for animals was first evidenced in 1957. However, it was not until 1973 that an enzyme called glutathione peroxidase was proven to be a selenoenzyme. At present, Se is known to be a normal component of several enzymes, proteins and some aminoacryl transfer nucleic acids. Certain Se compounds have been reported to possess anti- carcinogenic properties. There is a considerable interest in understanding the role of selenium in biological systems. We have developed a number of analytical methods for the determination of total selenium, bioavailable fraction of selenium, selenium species, and selenoproteins in nutritional materials using neutron activation analysis (NAA) in conjunction with several bioanalytical techniques.

Selenium has six stable isotopes which produce seven nuclides on thermal neutron activation. Among these nuclides, ^{77m}Se (half-life=17.4 s) and ^{75}Se (118.5 d) are most suitable for measurement by instrumental NAA (INAA). The short-lived ^{77m}Se nuclide can be used to considerably reduce the total experimental time and cost of analysis as well as to improve precision and detection limits by using cyclic INAA (CINAA) and pseudo-cyclic INAA (PCINAA). We have investigated both the CINAA and PCINAA methods in detail and optimized them for the best sensitivity, detection limit, selectivity, rapidity, precision and accuracy of measurements. We have also developed ion exchange, solvent extraction, solid phase extraction, HPLC, gel filtration, chromatofocussing, electrophoresis, and isotachophoresis methods for the characterization of selenium species and selenoproteins. The application of these and other methods to foods will be presented.

ON THE PROBLEMS OF REGIONAL ECOTOXICOLOGY

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At the end of 20th century at the interface between ecology and toxicology there appeared a new research direction, ecotoxicology, that studies ecological consequences of environmental pollution by means of the investigation of xenobiotics metabolism in living systems. The effect of antropogenic chemical substances on man and nature has a global character and that is why there is a necessity to integrate the activities of different countries into a joint system of stable development and protection of the environment and human health. It is the regional peculiarities of the problem that form the module of ecological safety. In this connection, hygienic estimates of environmental objects (air, soil, water) in a large ferrous metallurgy center in the south of the Urals are presented.

The characteristic feature of pollution in the region is the existence of an increased content of bensapyren and a complex of heavy metals most hazardous of which are lead, cadmium, chromium, nickel, beryllium, arsenic.

As a consequence of above facts there are discussed and indices of the reproduction health in women (stillbirth, early neonatal mortality, infant mortality, inherent anomalies in children, infertility, unfavorable birth, bronchial asthma in children, the number of malignant tumor cases in the area). Higher values of the discussed indices than in the other regions of Russia or elsewhere in the world as well as the fact that they tend to grow are noted.

Long-term bioeffects of the heavy metal complex on human population are confirmed by the results of analysis of biological liquids (blood, urine) and biological tissues (lung, kidney, aorta, breast) for heavy metal contents. In the investigated tissues there are observed the contents of silicon, nickel, chromium, lead, beryllium, iron and antimony, exceeding their standard contents in an average person. Bioaccumulation of metals reflects the quality of the environment.

Conclusions.

1. Prevailing environmental pollutants in the southern parts of the Urals are heavy metals with a toxicity of the first or second class.
2. First priority investigations in the region must be:
   - Monitoring and biomonitoring of the contamination of the atmosphere and soils by heavy metals.
   - Investigations of drinking water with an accent on the antimony content.
   - Estimation of hazardous effects of toxins.

The selection and preparation of tissue samples were conducted by the method of Hans Y. Seiler (University of Basel). The probes were analyzed on the Liberty-200 ICP atomic emission spectrometer and the Shtctr-AA-300 Plus absorption spectrometer.

MOBILISATION OF TOXIC ELEMENTS IN THE HUMAN RESPIRATORY SYSTEM

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The fate of respired particles in the respiratory system is inferred through the chemical characterisation of individual particles at the trachea and bronchi mucosa, and the accumulation of toxic elements in lung alveoli and lymph nodes.

The particles and tissue elemental distributions were identified and characterised using micro-PIXE elemental mapping of thin frozen sections using the ITN Nuclear Microprobe facility.

Significant particle deposits are found at distal respiratory tract. Al, Si, Ti, V, Cr, Fe, Ni, Cu and Zn are elements detected at these accumulation areas. The elemental distributions in different cellular environments of lymph nodes vary. If the major compartments for Si, Ti, Fe and Cr are the phagocytic cells and capsule of lymph nodes, for V and Ni the cortex and paracortex medullar areas retain more than 70% of these elements, suggesting high solubility of the latest in the cellular milieu. The elemental mobilisation from particles or deposits to surrounding tissues at the respiratory ducts evidence different patterns of diffusion and removal of elements in the respiratory tract. Mobilisation of elements such as V, Cr and Ni, is more relevant at alveoli areas where gaseous exchange takes place. The apparent high solubility of V and Ni in the respiratory tract tissue point towards a deviation of the lymphatic system filtering efficiency for these elements.

RADIONUCLIDE AND HEAVY METAL POLLUTION IN ROMANIA

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Romania, a country of about 23 million people, has a total area of 237.000 km^2, of which over 60% are agricultural lands. Annually about 140 million tons of polluting substances are emitted into the atmosphere, including non-ferrous, metal (Cd, Pb, Zn, Cu etc.) compounds with severe toxious effects on the environment. Most essential industrial metal compound emissions result from mining and non-ferrous ore processing, as well as from power plants using coal. All these emissions associated with gaseous ones (from fertilizer and power plants) containing SO_x and NO_y, intensify the capacity of toxic metals in soil and water. The soil has the capacity to store heavy metals and release in solution the stored elements. When the soil is heavily loaded with heavy metals and its physicochemical properties favour the metal mobility, excessive metals transfers from soil into water and plants damaging the ecosystem equilibrium.

Another source of environmental concern is the radioactivity of natural phosphates used in fertilizer plants, some of them being located along the Danube river and Romanian Black Sea coast.

In the sulfuric acid fertilizer process sulfur is thrown away as gypsum, mostly contaminated with radium. In the nitric acid process, nitrophosphate fertilizers contain uranium and its decay products. Uranium may have some cumulative effect in soil as a heavy and radioactive element. It should be also noted that in nitrophosphate fertilizers there is incorporated all rare elements from phosphate rock.

The obtained fertilizers as well as by-products and phosphate raw material used in Romanian fertilizer industry have been investigated by the instrumental neutron activation analysis (INAA) in order to check the level of radioactive elements (Th, U, Ra) and stable pollutants like As, Sb, Cr, Cr, Zn, Cd, Cu etc., as well.

The same method has also been used for rare earths and heavy metal analysis.

Although, investigations of heavy metal pollution in Romania are in the beginning stage, their results, however, represent a real alarming signal for the national environment and not only. Negative changes induced in fauna and flora (decrease of vegetal mass, chlorosis, burns, accumulation of heavy metals in fruits and edible organs) are of great environmental concern.

ENVIRONMENTAL SAMPLING AND ANALYSIS OF COAL FLY ASH INTENDED FOR USE IN ROADS: MN/DOT'S FINDINGS AND THEIR POTENTIAL IMPACTS ON ENVIRONMENTAL HEALTH DECISION-MAKING

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Government and private organizations around the world are currently encouraged to recycle wastes that were formerly placed in toxic waste landfills based on concerns for human and environmental health impacts. As a result, potentially toxic wastes are being diverted from monitored landfills to consumer and construction products. Unfortunately, the shift of these materials from the status of "land filled wastes" to "commercial products" has not been accompanied by routine product testing to determine product chemical and physical consistency over time. One such waste, coal fly ash, has been strongly recommended by government agencies and the private sector for use in Minnesota Department of Transportation (Mn/DOT) road projects, both mixed with soil beneath roads and in pavement. Through preliminary environmental sampling, extensive literature reviews and discussions with analytical chemistry experts, Mn/DOT has determined that much of the analytical data on coal fly ash presented in the literature may significantly under-report actual coal fly ash metal concentrations. As a result, material once thought to represent minimal environmental hazard to human health and the environment may, in fact, pose significant hazards. This paper will discuss Mn/DOT's methods and findings, to date, concerning the potential hazards of coal fly ash.

RADIECOLOGICAL INVESTIGATIONS IN INSTITUTE OF NUCLEAR PHYSICS OF THE ACADEMY OF SCIENCES OF KAZAKHSTAN

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During last years, by active support of international organizations (IAEA, ISTC, NATO and others), in the INP, NNC RK, there was created and developed the complex apparatus-material basis providing a solution of a large number of varied problems connected with radiation monitoring and the study of radioecological situation in different regions of Kazakstan. The basic installations are: atomic reactor "WWR-K", isochronous cyclotron "A-150", cascadeous recharge accelerator of heavy ions "ACR-2", complex of modern spectrometrical equipment (ORTEC, CANBERRA), EPR-spectrometer "Brunner ESP-300E", electronic microscope "AMRAY-120", atomic-emission spectrometer with inductive-coupled plasma "JY-70P".

The methodical complex includes:

- radionuclide analysis (instrumental, radiochemical);
- elemental analysis (activation analysis, XRF);
- mass-spectrometry (MS);
- EPR-spectrometry ;
- electronic microscopy (EM);
- PIXE with micro-sonde.

In the Institute there is produced the new methodological approach to the study of a degree and a character of radionuclide contamination of former nuclear test sites. There is organized the field team for carrying out of radiometrical measurements at locality and for selection of probes of environmental objects with precise determination of geographical coordinates.

The methodology of radioecological investigations (developed in INP NNC RK) and the developed experimental-methodical basis are widely used to study forms, structures and behavior of variability of radionuclide contamination of the Semipalatinsk NTS (together with Los-Alamos National Laboratory, USA), of the Test Site "Azgir", of objects "Lira", "Batolit" and of other places of carrying out of nuclear tests. There are performed works on the radiation monitoring of territories of "Lira" objects and of the basin of the river "Syrdarya" (together with "Sandia" National Laboratories, USA). There is begun work on inspection of artificial water-storage "Kashkar-Ata", being a receptacle of waste of uranium industry of mountain-metallurgical mill in Aktau-city, Western Kazakhstan.

All results of radioecological investigations are set into DataBase developed in the Institute.

DETERMINATION OF HEAVY METALS IN HUMAN MILK AND HAIR

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Heavy metals belong to one of the most dangerous groups of anthropogenic environmental pollutants. This is due to their toxicity, bioaccumulation, persistence in the environment and biomagnifcation in the food chain. Metals can be transported with food, water and air, and can enter human organism also with breathing and drinking water and can be determined in human milk and hair.

Metals have been analysed, after mineralisation in PTFE bomb with microwave radiation and nitric acid, by means of FAAS and ETAAS using Buck Scientific 210 VGP Absorption Spectrophotometer.

Samples of hair were collected from women living in the Tricity Area (Gdansk, Sopot, Gdynia) and samples of milk were taken from women from the maternity ward at the hospital in Gdansk-Zaspa.

Generally, the relation between some analysed metals concentrations in hair and the state of health have been observed. The influence of environmental pollution on heavy metal concentrations in hair and milk has also been observed. The highest metals concentrations, especially lead and cadmium, were observed in the milk and hair of women living in the vicinity of busy roads. No correlation between smoking and concentration of cadmium or lead in women milk was observed.

Human hair seems to be a very good sample for biomonitoring of environmental pollution by heavy metals. Levels of metals in hair are highly correlated with their contents in the internal organs and other tissues and can be several hundred times higher than in blood and urine. The content of heavy metals should be controlled in human milk due to their toxicity for children.

HUMAN HAIR COMPOSITION IN ENVIRONMENT MONITORING AND MAPPING

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The key task of environment monitoring is to detect the present situation and to estimate the trend of the situation development. Environmental monitoring is usually carried out by sampling and analysis of rough airborne particulate matter (usually trapping and analysis of ultra-thin particles and gas-vapor phase remain out of consideration), dry and wet precipitations, surface water (liquid phase, solid phase, and bottom sediments) soil, biota (plants and animals liquids and tissues), etc. This approach is a quite convenient and informative in smaller in size studies or in case of an environmental accident with significantly elevated levels of contaminants in the vicinity of a single source of contamination. This approach is hardly acceptable for a large area characterization or mapping of the situation because of extremely elemental composition temporal changeability and spatial mosaicity. These difficulties need permanent or very frequent sampling and a very huge number of analyses. This is why the researchers in life sciences are trying to find the sample which is able to accumulate and average the environmental situation.

Lichen and mosses are very promisable in this connection but in many arid regions they do not exist. There were studied possibilities to use bee-honey, cob-web, etc.

One of possible indicators of large areas mapping is human hair. Human hair composition reflects both human body elemental status and the environmental situation. Changes are «recorded» along the hair and may be dated. An important advantage is the simplicity of sampling.

In our Institute for many years neutron activation analysis has been carried out studies to map different in scale areas – single city, region, country, the whole world. The obtained maps allowed making interesting conclusions and are briefly considered in the present talk.

It is shown in the present contribution that extremely informative is a mapping using hair of children (kindergarten), because of a much smaller scale of movement (usually the kindergartens are situated close to children's houses) and the absence of occupational exposures.

Very important is the possibility to compare hair elemental compositions with the health status. In many cases there were found statistically significant correlations of hair composition and health status.

NEUTRON-PHYSICAL CHARACTERISTICS OF THE SYSTEMS «U/PB TARGET – RELATIVISTIC PROTONS» IN THE ENERGY RANGE FROM 0.5 TO 7.4 GeV

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Researches of different aspects of ADS and ADTT were carried out in the last years. A series of experiments for studying the transmutation of ^{129}I and ^{237}Np was performed at the the Synchrophasotron of the Laboratory for High Energies(JINR, Dubna) using relativistic protons and target with different compositions (containing uranium and/or lead with or without paraffin moderator.

In these experiments we have continued to study the spatial and energy distribution of neutrons inside and outside the targets. The necessity of such data is caused by an insufficient reliability of the theoretical prediction of the neutronics of the nuclear-physical facility. The fission density of uranium and transuranium nuclides as well as the average fission cross-section ratios or spectral indices (SI) provide information about the spectral neutron flux in the nuclear-physical facility. The values of SI may be measured with a high precision. A comparison of the computation and experimental results allows identifying of the sources of errors in the calculation of the characteristics of nuclear-physical facilities.

Nuclear track radiography was used as a detection technique. The sandwiches consisting of targets- radiators containing a fissile substance and solid state nuclear track detectors (SSNTD) were applied for the measurement of the axial and radial distributions of the fission density of thorium and uranium isotopes as well as for the measurement of the average fission cross-section ratios. The distribution of the neutron flux density on the surface of the paraffin block was determined for the experiments carried out with the *U+Pb* facility with paraffin moderator and relativistic protons with the energies 0.5 - 7.4 GeV. The spectral indices $\bar{\sigma}_f^{234U}/\bar{\sigma}_f^{235U}$, $\bar{\sigma}_f^{236U}/\bar{\sigma}_f^{235U}$, $\bar{\sigma}_f^{237Np}/\bar{\sigma}_f^{235U}$, $\bar{\sigma}_f^{232Th}/\bar{\sigma}_f^{235U}$ and the ratios of the ^{235}U fission densities with and without cadmium and boron filters were measured in the central point on the surface of the paraffin moderator.

HEAVY METALS IN THE ENVIRONMENT OVER RUSSIA: DATA OF THE INTEGRATED BACKGROUND MONITORING NETWORK FOR LAST DECADES

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The brief overview of the Integrated Background Monitoring Network (IBMoN) in Russia, which was established as a specific observation system for the realisation of integrated approach to environmental pollution control, is presented. The Network was created by the USSR State Committee for Hydrometeorology and Environment Control at the end of 1970-s and had been considered as a part of UNEP Global Environmental Monitoring System (UNEP/GEMS). After 1990, the IBMoN network is developed according to CIS-member co-operation in the frame of inter-governmental Council for Hydrometeorology. The IBMoN stations are situated far from areas with direct anthropogenic influence and their measurements could be attitude to regional and background monitoring. The programme for the integrated background monitoring of environmental pollution includes sampling and analysing of ambient air, precipitation and deposition, snow cover, soils, bottom sediments and biota. The Network is operating under the scientific and methodical support of the Institute of Global Climate and Ecology (Moscow, Russia) which is also responsible for handling, storage and assessment of data.

The detail description of measurement programme covering principles of sampling, analysis and data handling for heavy metals in the environment is presented. Measurement program, sampling procedures, methods of laboratory analysis, principles of data interpretation and publications, data quality assessment and temporal periods of data collected are examined from the point of their use for the evaluation of environmental contamination levels and atmospheric depositions of heavy metals.

The results of statistical calculations carried out for long-term rows of IBMoN measurement data on heavy metal concentrations in air and precipitation are presented for period of 1982-1996. Long-term (up to 15 years) trends of changes were evaluated for atmospheric lead, cadmium and mercury in Russia based on their annual and seasonal averaged values of concentrations. The first-order assumption calculation of dry and wet deposition of lead, cadmium and mercury produced for the year of the most complete data sets both spatially and temporally was performed and their results are presented.

CHEMICAL ELEMENTS IN ATMOSPHERIC AIR OF MOSCOW

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Our Institute in collaboration with other organizations will carry out an assesment of the environment of some cities of Russia, including Moscow in 1976. The basic objects of research are soil, snow, sediments, water, and atmospheric air. In the main, most toxic chemical elements (V, Cr, Mn, Co, Ni, Cu, Zn, As, Cd, Sb, Hg, Pb) and contents of rare elements in the territories, where they are emitted are investigated.

The data about chemical elements concentrations in background and urban aerosols are generalized and systematized. Three questions are discussed. They are the distribution of elements between aerosol particles, peculiarities of spreading of elements for pollution sources of various types; temporary concentration levels variations of chemical elements for different estimated coefficients.

The size of aerosol particles is the main parameter, defining their behaviour in the atmosphere and the ecological importance of natural and antropogenic sources of pollution. Therefore, it is reasonable to conduct a scientific estimation of the degree of pollution of the atmosphere by aerosols, taking into account harmful effects of aerosols to human health, which must be only based not on measurements of the element structure but also take into account the size of air particles and distribution of elements on particles of various sizes. It is connected with the fact that to the bottom bodies of breath there penetrate particles with the size less than 1 μm. Larger particles precipitate in the top bodies of breath.

Studying of distribution of chemical elements as a function of the size of carrying particles in various regions, including background territories and cities has allowed us to reveal a definite law. It says that such elements as Co, Ag, Sn, V, Au, Cr, Zn, Sb, B, Se, Pb, As, Br, Hg, are connected with fine particles the the size smaller than 2μm. On larger particles, 2-10 μm, there are mainly concentrated matrix elements (Si, Al, Mg, Ca, Fe, Na). Therefore, alongside with the determination of the general content of the chemical element in air, it is also necessary to pay attention to the character of the distribution of most toxic elements as a function of the size of carrying particles.

In the analysis the structure of pollution due to metallurgic industry is established. Such elements as As, Cd, Ni, Pb, Sb, Se, Zn, transform into the volatile state as a free vapor at high temperatures. Some elements, even in natural conditions, exist in the «free molecular» state (Hg, I, etc.).

With the help of special filtres the data of the presence of chemical elements at «free molecular» phase are collected in contrast to the earlier methods of control of atmospheric air, because cellulose filters used in Russia do not catch particles of the size less than 0.03 μm. Repeated measurements of chemical elements with the help of special filtres catching molecular chemical elements have established that the elements Sb, As, Se, Hg, Br, Ni, Cd, B are present as a free vapor.

Repeated daily tool measurements of the concentration level of chemical elements in the atmospheric air of cities is an important necessity of estimating the quality of atmospheric air. The realization of continuous researches of the quality of atmospheric air allows one to establish the dynamics of changes in the quantitative and qualitative structure of chemical elements in atmospheric air.

To estimate the degree of pollution, the background level of chemical elements in objects of the environment in various regions with different landscapes and geological conditions is determined. The choice of methods of analysis should provide the necessary set of controllable substances with a high degree of accuracy of the analysis and reproducibility of results with various methods (INAA, XRF, AAS, ICP-AE), so that the quantity of samples should be sufficient for statistical processing.

ATMOSPHERIC DEPOSITION OF TRACE ELEMENTS IN ROMANIA USING THE MOSS BIOMONITORING TECHNIQUE

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The paper presents the results of three yearly moss surveys in 1995, 1998, and 1999 in Romania. The Institute of Physics and Nuclear Engineering in Bucharest conducted biomonitoring of epiphytic mosses, *Hylocomium splendens*, *Pleurosium schrebery* and *Hypnum cupressiforme*, over a regular grid (e.g. 20x 20 km^2). The sampling area comprises over 40 % of the Romanian territory and in the nearest future it will be extended to the whole territory. 43 trace elements and major elements were identified by epithermal neutron activation analysis carried out at the Joint Institute for Nuclear Research in Dubna, Russia. Copper, cadmium and lead were determined by atomic adsorption spectrometry in the Mining Research and Design Institute in Baia Mare, Romania and Norwegian University of Science and Technology in Trondheim, Norway. In order to characterize the main sources of air pollution in Romania, Principal Component Analysis was applied to the entire data set and three data sets. Significant Pearson correlation coefficients between pairs of elements were interpreted by means of factor analysis with varimax rotation. At least 78% of the total data could be explained by seven principal components. The first two dominant factors are related to the following elements: first factor has similar loadings for Sm, Th, U, Tb, V, La, Yb, Mg, Ce, Na, Fe, Cs, Al, and Sc and may be explained by soil dust, and also, contributions of local industry; the second factor is mainly due to loadings highly on As, Mo, Se, Zn, Sb, Ag, Au, and Co indicating that the local industry is an important source of them.

The results obtained for Romanian mosses are compared with those obtained at the Joint Institute for Nuclear Research for Central Russia, Ural, Norway (Mo smelter complex), Poland (Copper Basin), and Bulgaria (Rodopi Mountains) and with some data from the "Atmospheric Heavy Metal Deposition in Europe -*estimations based on moss analysis*" 1995 and 1995-1996 reports.

ATMOSPHERIC DEPOSITION OF HEAVY METALS IN THE SOUTH URAL MOUNTAINS, RUSSIA

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Monitoring of large-scale atmospheric depositions of heavy metals with terrestrial mosses and lichens is well established in Nordic countries and Western Europe. During the last few years it has also been applied in Eastern Europe. It follows the concept of analyzing the atmospheric deposition of metals by using the mosses *Hylocomium splendens* and *Pleurozium schreberi* as adopted by the European Atmospheric Heavy Metal Deposition monitoring project [1]. Applied to one of the most polluted areas in the world not yet covered by the European moss-survey – the South Ural Mountains, a military and industrial center of the Russian Federation – this methodology will allow to broaden significantly our understanding of air pollution in Europe. This area is considerably affected by radionuclides and heavy metals considering their large past and present atmospheric emissions [2,3].

Moss samples were collected at the 66 sites in the Chelyabinsk region and in the region south of Sverdlovsk, including those from the pilot study of the authors [4]. Two complementary analytical techniques were employed: epithermal neutron activation analysis (ENAA) at the IBR-2 pulsed fast reactor in Dubna and atomic absorption spectroscopy (AAS) at the Geological Institute of RAS, Moscow. A total of 38 elements (Na, Mg, Al, Cl, Ca, Sc, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Br, Rb, Sr, Mo, Ag, Cd, In, Sb, I, Cs, Ba, La, Ce, Sm, Eu, Tb, Yb, W, Au, Pb, Th, U) are reported from the results obtained.

To obtain information on the character and origin of pollution sources from thr element concentration patterns determined from moss and lichen data sets, techniques of multivariate statistical analysis (factor analysis) followed by a graphical technique for post-analytical quality control, are applied. Coloured contour maps of elemental depositions in the areas of interest have also been generated by using GIS-INTEGRO with raster and vector graphics. The results obtained form a unique database that documents the air pollution in the South Ural Mountains at the beginning of the twenty-first century and serves as a starting point for the next generation of environmental researchers.

This study was carried out in the framework of the IAEA coordinated research project «Biomonitoring Air Pollution in Chelyabinsk Region (Ural Mountains, Russia) Through Trace-Elements and Radionuclides: Temporal and Spatial Trends» (No. 9939/R2/ Regular Budget Fund).

REFERENCES

[1] RÜHLING Å., STEINNES E. Atlas: Atmospheric Heavy Metal Deposition in Europe 1995-1996, Nordic Council of Ministers, Nord 1998; pp 7-54.

[2] BRADLEY, D.J., Behind the Nuclear Curtain. Radioactive Waste Management in the Former Soviet Union. Edited by David R. Payson, Battelle Press, Columbus Richland, 1977, p. 371-450.

[3] Air Pollution in the Ural Mountains, NATO ASI series, 2. Enviroment – Vol.40, Kluwer Academic Publishers, 1998, p. 455.

[4] FRONTASYEVA M.V., STEINNES E., LYAPUNOV S.M., CHERCHINTSEV V.D., SMIRNOV L.I.. Biomonitoring of Heavy Metal Deposition in the South Ural Region: Some Preliminary Results Obtained by Nuclear and Related Techniques, J. Radioanal. Nuclear Chemistry, Vol. 243, No.2, 2000.

[5] VOLOKH A.A. Atmospheric Air Pollution by Metals and Volatail Organic Compounds in Urban and Remote Areas. In Geochemical Investigations of Urban Aglomerations, Institute of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements of RAS, Moscow, 1998, pp. 40-58.

EPITHERMAL NEUTRON ACTIVATION ANALYSIS OF MOSSES USED TO MONITOR HEAVY METAL ATMOSPHERIC DEPOSITION IN TULA REGION

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The method of moss biomonitoring was used to study heavy metal atmospheric deposition in Central Russia (Tula Region) applying NAA and GIS technology. Tula, one of the ancient Russian cities, is located 200 km south of Moscow. The Tula Region is known for clustering of machine-building, metallurgical heavy industry, chemical and mining enterprises. For the first time a wide set of heavy metals and other toxic elements was determined. Moss sampling was carried out in accordance with the sampling strategy adopted in European projects on biomonitoring of atmospheric deposition. In addition to moss biomonitors, such as *Hylocomium splendens* and *Pleurozium schreberi*, the moss *Calliergon geganteum* widely distributed in the given climatic conditions was used. The method of epithermal neutron activation at the IBR-2 reactor of FLNP JINR has made it possible to identify 43 elements, in the examined samples collected in the north part of the Tula Region. Among heavy metals (Al, Sc, V, Cr, Mn, Fe, Co, Ni, Zn, Sr, Mo, Cd, W), As, Se, halogens (Cl, Br, I), rare-earth elements (Ce, Sm, Eu, Gd, Tb, Dy, Tm, Yb, Lu), as well as U and Th were determined. The obtained data are used to construct colored maps of the distribution of elements over the investigated territory. An interspecies calibration of mosses carried out in the present study is discussed. The local deposition patterns of pollutants, such as As, Cl, Sb, V were revealed.

CONTENTS OF METALS IN GLUES AND RHIZOME OF A WATER PLANT FROM LAKES OF NORTHWEST OF RUSSIA

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The contamination of environment in the North of the European Terrain of Russia by such metals as Cu, Cd, Zn, Pb, Mn, Fe is, probably, connected with the effect of black and color metallurgy in large industrial centres. To estimate the limens of diffusion of heavy metals from the metallurgic plant samples of mosses (Pleurozium sp., Hyloconium sp., Sphagnum sp.) were collected in the south direction from Cherepovets. The contents of metals (Cd, Sr, Cr, Cu, Pb, Fe) and the level of ashes of the investigated mosses as a whole reduce as the distance from the source of emission increases. The local influence of the industrial center decreases sharply at a distance of 20-30 kms. Further augmentation of the distance in the assessment of the effect of metals on ecosystems is inexpedient, as there start to appear other metals polluters, which are possible to be refered to the heating of settlements. Most far from Cherepovets (62 kms) is the field of sampling of mosses at 4-5 kms from the village. In this place the contents of some metals (Sr, Cu, Pb, Fe) increase. Despite the similarities of changes in the accumulation of metals between the investigated mosses, Sphagnum is least successfully represented.

For the assessment of influence of acidification of lakes on the mobility of metals specimens of rhizomes of a representative of water plants (Nuphar luteum) in 20 small lakes of the Kareliya and Vologda regions were collected. The lakes differ by the level of pH, color and mineralization of water trophic status. It was shown, that rhizomes in acidified lakes (pH of water < 5.5) hold, as a rule, more metals, than plant from neutral and intermediate lakes (pH of water > 5.5). Statistically authentic differences are, however, only placed for copper. A similar allocation was marked earlier at studying the contents of metals in rhizomes Nuphar luteum from the lakes of Finland (Verta et al., 1990). It is necessary to mark that in an overwhelming majority of cases the levels of accumulation of metals in rhizomes appear to be low, than the contents of metals in bottom deposits of the investigated Russian lakes.

CONTENTS OF MERCURY IN FISH FROM RESERVOIRS OF NORTHWEST RUSSIA: MAIN CAUSES OF HIGH LEVELS

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The density of atmospheric depositions of mercury in the terrain of Northwest of Russia (20 - 45 g/m squ per one year) is those, that at complete absorption by fish of metal, falling down only on a surface, without the count of deposition on watershed, the levels of accumulation of xenobiotic for 1 year would exceed extreme valid values at 2-20 times and compounded in absolute values 1 - 10 mg/kg. However, the parameters of accumulation of mercury only in a fish from acidified lakes (0.5-3.0 mg Hg/kg) come nearer to these values. This is promoted some by the factors, key value from which have the following. At lowering a level pH of water there is depressing processes of bacterial decomposing of organic matter and in lake the congenial oxygenous mode is shaped. The bonds of mercury are not concervated in the form of sulfides in bottom deposits, and switch on in flows of organic matter, the lobe of the methylated form of mercury - biologically accessible to hydrobionts is enlarged. Lowering of a biomass of the phytoplankton and the low level of processes of a primary production enhances a role of organic matter from watershed - main care agent of mercury in a superficial drain. In a food of the perch rather slowly growing and sole species of fishes in acidified lakes, dominate larval and imago of the insects with a durating life cycle, instead of youth of fishes (better a diet), as it is characteristic of neutral reservoirs. That is why up to 80 % of mercury in ecosystems of acidified lakes is in a fish and invertebrates, while for neutral lakes this parameter does not exceed 30 %.

The correlation analysis has allowed to install statistically authentic connection between the value of a biomass of zooplankton and accumulation of mercury in muscles of the perch. The regression of mercury contents in fish (20 lakes) from biomass of the zooplankton has appeared so significant, as well as dependence on pH water level. The analysis of mercury contents in muscles of the one-sized perch from Ivankovskoye, Uvodskoye and Rybinskoye (Mologa, Sheksna, Volga and Main bays) reservoirs which have no strong acidification effects, has revealed differences between sampling. The contents of metal in muscles was higher there, where the maximum values of a biomass of the zooplankton and minimum phytoplankton registered. The dependence of accumulation of mercury in muscles of the perch from a biomass of bacterioplankton is not detected, that means not its absence, but lack of the information. Reservoirs as a whole and separate bays represent more complecated systems, than lakes, in the hydrodynamic and hydrobiological aspects. The obtained digital expression of dependence of accumulation of mercury in muscles of the perch from biomass of phyto- and zooplankton is not absolute, and is first of all qualitative characteristic of the process of mercury migration in ecosystems of a reservoir, when the development of heterotrophyc link in planktonic assemblages is intensifying mercury accumulation in the end point of trophic chain. The intensity of a linear growth of fishes can be considered as the essential factor influential in bioaccumulation of mercury. The representatives of fast growing species, for example pike-perch or pike, to 5-year's age in Rybinsk reservoir achieve mass of 1.0 - 1.5 kg, while the perch - only 0.2-0.3. The perch from acidified lakes grows even more slowly and its weight not always exceeds 100. Among one-sized fishes of Rybinsk reservoir the perch has both greatest age and highest contents of mercury in muscles.

ENZYMATIC METHOD FOR HEAVY METALS DETERMINATION IN WATERS AND SOILS

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Enzymatic methods of analysis are extremely advantageous for environmental monitoring. The application of enzymes is worth especially, for the determination of physiologically active compounds due to unique sensitivity of biocatalysts to the influence of such compounds as activators or inhibitors of enzymatic processes.

Mercury(II) was shown to be the most effective inorganic inhibitor of horseradish (HRP) and peanut (PNP) peroxidases in the reaction of *o*-dianisidine oxidation with hydrogen peroxide. The procedures for mercury(II) determination were worked out with the detection limits 0.01 and 0.1 ng/ml, respectively. The application of PNP makes the procedure of mercury(II) determination more rapid and simple because it does not require the addition of a sulfur-containing inhibitor – thiourea, and preincubation of the enzyme with these two inhibitors (such steps are necessary in the case of HRP).

The procedures for cadmium(II) and bismuth(III) determination based on their action on the rate of o-dianisidine oxidation in the presence of diethyldithiocarbamate catalyzed by HRP were developed with the detection limit 50 ng/ml. Using of different analytical signals the indicator reaction rate for cadmium(II) determination and the induction period duration for bismuth(III) determination allowed us to determine these inhibitors at their combined presence.

The inhibitory effect of lead(II) towards the activity of alkaline phosphatase in p-nitrophenylphosphate hydrolysis has been used for developing a procedure for the determination of 0.3-10000 ng/ml lead(II).

The test procedures for 0.1-1000 pg/ml mercury(II) and 1.0-5000 pg/ml cadmium(II) were developed on the basis of their inhibitory effect on the catalytic activity of horseradish peroxidase immobilized in the natural polymer chitosan on a polyurethane foam in the o-dianizidine oxidation reaction.

Alkaline phosphatase immobilized in N-phthalylchitosan on a polyurethane foam was applied for the determination of 0.05-10000 ng/ml lead(II). The reaction of p-nitrophenylphosphate hydrolysis was used as an indicator.

All developed procedures and test methods were successfully applied for the determination of heavy metals in natural waters and soils of different types (microwave radiation was used for soil samples pre-treatment). The obtained results were coincident using the atomic absorption spectroscopy method.

NUCLEAR AND RELATED ANALYTICAL TECHNIQUES USED TO STUDY ANTHROPOGENIC IMPACT ON THE RIVER SISTER IN THE VICINITY OF THE TOWN OF KLIN (MOSCOW REGION, RUSSIA)

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The ecological fate of small rivers, tributaries of the Volga River, is of great concern in the national program of the Russian Federation "Restoration of the Volga River". The results on the elaborated hydrochemical and saprobiological water examination of a Sister River are reported along with the results on the multi-element chemical analysis of surface sediments in the catchment of the town of Klin (Moscow Region) known for its numerous industrial and chemical enterprises with heavy contaminant inputs.

Epithermal neutron activation analysis was used to study heavy metals and other toxic elements in bottom sediments. A total of 42 elements were determined including Pb, Cu, Cd and Hg determined by polarography (method of inverse voltamperometry).

Metal/Al rations which express the relative mobility of the elements follow the sequence: Fe>Mg>K>Na>Ca>>Zr>Mn>Zn=Sr>Cr>V>Ni=As>Co. Elevated concentrations of Cd, Pb, Zn and Cu in the bottom sediments of the Sister River reinforced us to determine their chemical forms using fractionation scheme. Cadmium is mostly associated with carbonate content and thus has a possibility of becoming readily bioavailable. Its toxicity and bioavailability poses a serious problem to ecosystem. Copper and zinc besides having less environmental risk are present in forms which they cannot be easily leached out. Accumulation of toxic metals, arsenic and oil products are of potential hazard for the secondary pollution of the surface waters.

It is shown that the main sources of pollution in the vicinity of the town of Klin are the domestic sewage waters and sewage waters from the chemical complex "Klin-Fiber" producing synthetic materials. The extremes of the distribution patterns of pollutants in the bottom sediments and water are to be found approximately 50 km down the stream from the discharge sources. The second source of geochemical anomaly is located upstream of the Sister River, before the town of Klin. It could be associated with the activity of the galvanic enterprises and to the discharge of processed electrolyte zinc-cadmium accumulators used in aviation. Comparison with available results on similar river bottom sediments is given.

Discharge of sewage water into the Sister River leads to intensification of bacterial processes, grown of population saprophytic and pathogenic microorganisms and other specific forms. Sedimentation of the oligosaprophytic forms is responsible for the decrease of population and biomass, degradation of bio-diversity of fresh water invertebrate.

A larger database is required to further test spatial and temporal pollution with heavy metals and other toxic elements in the basin of the Sister River.

RELATIVE ELEMENT CONTENT IN OILS AND LIVING ORGANISMS

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Experimentally determined element compositions of oil and living organisms against the background of general element abundance in the Solar system was compared.

In Figs. 1-3, decimal logarithms of the ratios of element-homologue concentrations, K_{Z_1}/K_{Z_2}=AR, are plotted, where Z_1/Z_2 = L/K, Na/K, Rb/K, Cs/K, Na/Rb, Na/Cs, Mg/Be, Mg/Ca, Mg/Sr, Mg/Ba, Ca/Sr, Ca/Ba, Sr/Ba, B/Al, S/O, Br/Cl, Ag/Cu, Au/Cu, Au/Ag, Cd/Zn, Hg/Zn, Hg/Cd, Sc/Al, Sc/La, Sc/Eu, Sc/Yb, C/Si, Si/Ti, Ge/Si, Sn/Ge, Sn/Pb, P/N, As/P, As/Sb, V/Nb, Ta/Nb, S/Se, Te/S, Te/Se, Cr/Mo, Cr/W, Mo/W, Mo/U, W/U, Re/Mn, and Ni/Fe in diabases of the Earth (basic rocks), W-1 (BR), stone chondrites, CH, oil, Oil, living organisms, OR, relative to those in the Sun (Solar system), Sun (Ss).

The straight lines (bisectrices), drawn through zero coordinates at the angle of 45^0 to the abscissa, correspond to the identity of relative element composition of the compared materials. The points in Fig.1a lie mainly below the bisectrix, while in Fig.1b they lie above it. The discrepancy of the data of W-1 (BR) and CH can be explained by the magnetic separation of elements in the Protoplanet nebula [1].

In Fig. 2a, the points, relative to light elements of I and II groups of the system of elements composing Oil [2], are plotted.

One can see from the data of Fig.2 a,b that practically in all cases the points lie above the bisectrix if the element, concentration of which forms the numerator, has a less stable oxide. Otherwise, the points lie below the bisectrix. Oil is enriched by elements with less stable oxides and more volatile chemical forms.

One can see from the data of Fig. 3 that all of the points are approximated to the straight line (bisectrix) and lie in a relatively narrow confidence corridor. Relative element composition of OR appears to be the most close to the less differentiated matter of the Sun (Universe).

The peculiar features of relative element composition of Oil could not be inherited during its organic origin from OR.

It can be inferred from the above data that the Mendeleev's hypothesis of the inorganic genesis of Oil can be transferred to the category of really existing natural phenomena.

References

1. Chuburkov Yu.T. Radiohimia, 1999, v. 41, No.5, p.409-415.
2. Nadirov A.K. et al. Metals in oils. Alma-Ata, «Nauka», 1984, 448 p.

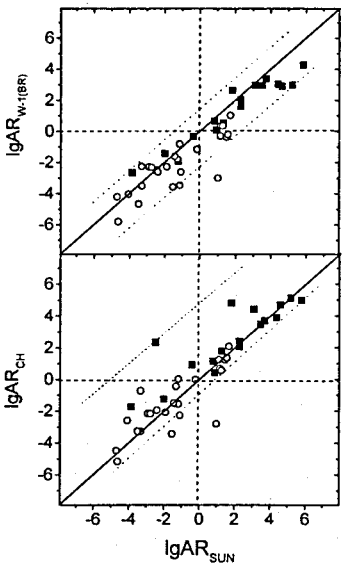

Fig. 1 (a, b)

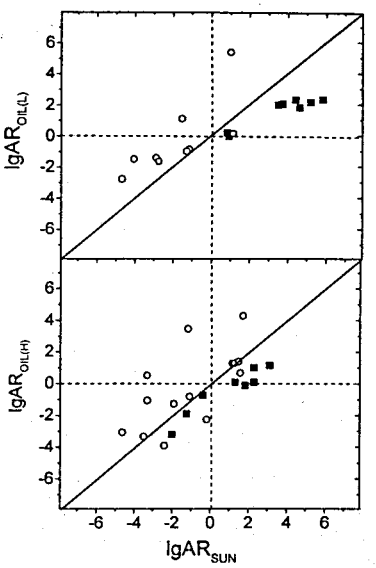

Fig. 2 (a, b)

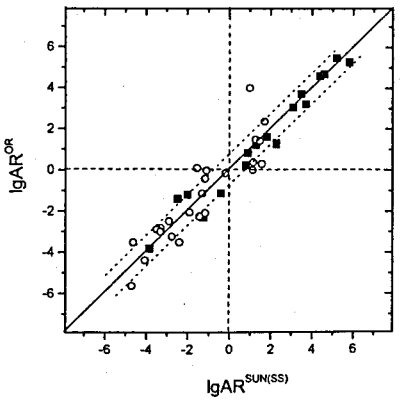

Fig.3

HEAVY METALS IN THE HAIR OF CHILDREN SUFFERING FROM BRONCHIAL ASTHMA AND LIVING IN AN ECOLOGICALLY CLEAN DISTRICT

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It has been established that disruptions in the elemental homeostasis control the development of bronchial asthma which is among the most widespread childhood diseases. For this reason, determinations of heavy metals in the biosubstrates of children is of both ecological and medical interest.

We analyzed the hair of 50 children, among whom 30 had long suffered from bronchial asthma and 20 were healthy. The epithermal neutron-activation technique was employed, at the IBR-2 reactor of the Frank Laboratory of Neutron Physics, JINR to determine the content of 32 elements.

Comparisons of the trace elemental hair compositions between the diseased and healthy children revealed a tendency toward the accumulation of heavy metals and some polluting elements in the hair of the diseased children. This tendency was most pronounced for Sb, Co, Au, Cs, Tb, Fe, and V; to a lesser extent, for Hg, S, In, and Ta. However, the accumulation was not due to heavy-metal environmental pollution. Both healthy and diseased children had constantly lived under relatively favourable ecological conditions, in the southwestern district of Moscow. Such an effect can be accounted for by the chronic inflammatory activity in the lungs of the diseased children; according to numerous experimental investigations, the above-mentioned elements are directly involved in these processes. The results obtained are illustrative of the diversified role played in the human organism by the metals that frequently manifest themselves as industrial pollutants of the environment.

IODINE- AND SELENIUM-CONTAINING PHARMACEUTICALS BASED ON THE BLUE-GREEN ALGAE *SPIRULINA PLATENSIS* MATRIX. NEUTRON ACTIVATION ANALYSIS FOR PRACTICAL MEDICINE

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To evaluate the potentiality of the blue-green algae *Spirulina Platensis* as a matrix for production of iodine- and selenium-containing pharmaceuticals, the background level of 31 major and trace elements (Na, Mg, Al, Cl, K, Ca, Sc, V, Cr, Mn, Fe, Co, Ni (using (n,p)-reaction), As, Br, Zn, Rb, Mo, Ag, Sb, I, Ba, Sm, Tb, Tm, Hf, Ta, W, Au, Hg, Th) in *Spirulina Platensis* biomass was determined by means of epithermal neutron activation analysis. The possibility of the purpose-oriented incorporation of I and Se into *Spirulina platensis* biomass was demonstrated. The polinomial dependence of the Se accumulation on nutritional medium loading was revealed. The employed analytical technique allows one to reliably control the amount of toxic elements in algae *Spirulina Platensis.*. Based on this study, an unequivocal conclusion of the possibility to use *Spirulina Platensis* as a matrix for production of iodine- and selenium-containing pharmaceutical was drawn.

ANTIOXIDANT INDICATORS IN FRESH WATER FISH POPULATIONS (LEUCISCUS ALBURNOIDES) EXPOSED TO INORGANIC POLLUTANTS AT A COPPER MINE AREA

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Evidence is growing for the importance of antioxidant enzyme activity measurements in eco-toxicology studies, as they may constitute markers for exposure to a large variety of pollutants. Variation of two antioxidant enzymes, superoxide dismutase (SOD) and glutathione S-transferase (GST) and effects of heavy metals and Se exposure on these enzymes, were investigated in liver from freshwater fish (*Leuciscus alburnoides*) captured at a copper mine.
The determination of GST activity showed an increase in the animals captured at Mines when compared to those from reference site for all seasons except in summer, while the activity of SOD did not present regional significant alterations, nevertheless seems to have a seasonal variation.
High levels of Cu and Se were observed in fish captured at the polluted area what is in agreement with the levels of these elements obtained through the environmental monitoring. The results suggest that GST could constitute a good biochemical marker for toxicity in populations exposed to metal contaminants, nevertheless it is necessary to proceed to laboratory tests in established conditions, with the purpose of helping a more clear interpretation of field's results.

Key words: Eco-toxicology, *Leuciscus alburnoides*, heavy metals, superoxide dismutase, glutathione S-transferase, bioindicators

EXPERIENCE OF THE USING OF RUSSIAN AND AMERICAN SATELLITE DATA TO IDENTIFY A STABLE BLOCK INTO PRECAMBRIAN FORMATION OF NW RUSSIA FOR MODELING HLRW DISPOSAL

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The Russian satellite images KATE 200 and MK4 on the scale 1:1,000,000-1:200,000 of the red spectral band have been structurally deciphered for the Southern Karelia. These data and evidence of low seismic activity suggest that the Archaean crust and especially the region of the Salmi rapakivi-granite intrusion is most stable with a low density of linear, small ring and radial faults. The densities of the lineaments were used for the map at equal density and allowed the separation of a minimally-disturbed area in the intrusion, that is a favorable site for the modeling of the HLRW repository. In addition to the investigations conducted in Russia, remote sensing studies of this area were undertaken at the PACES and the University of West Georgia Remote Sensing Laboratory. The LANDSAT images on the 1:250,000 and 1:100,000 scale for the same region have been georeferenced using the published topographic maps. RGB bands 472 applied to the images were selected for maximum separation, elimination of atmospheric effects, and de-emphasis of vegetation. After comparative examination of these images and structural deciphering of its copies by the Russian side, it may be determined that the utilization of the LANDSAT as well as the Russian satellite data and the selected thematic spectral bands has produced a useful tool for site evaluation of regions as a geologic model of HLRW disposal.

CHEMICAL NATURE OF SEISMIC PHENOMENA

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The causal relationship between seismic phenomena and earth crust tectonics does not give stable positive results yet when attempts of predicting catastrophic earthquakes, volcano eruptions, and similar phenomena are made. The reason of seismology failures has to do with the fact that all the data, gathered in this domain of science are considered within the frame of chondrite (silicate) mantle composition which remains an unproven postulate up to now.

In addition, the amount of data, which cannot be explained within this silicate postulate, is increasing. In [1-3], some of the above data are mentioned: mantle matter heterogeneity found by seismotomography, Tunguska explosion in 1908, late origination of vertebrates in the sea ($6 \cdot 10^8$ years ago), and inorganic synthesis of oil. From the data of [1-3], one can see that the above phenomena, related to different divisions of science, can be explained under the same assumption. Evidently, this four-time coincidence cannot be accidental. A necessary and sufficient assumption is the existence in mantles of earth-type planets of matter composed of Na, Mg, Al, Si, K, and Ca and not containing oxygen in stoichiometric proportion. The mantle matter is oxygen deficient. Only in this case vapor-phase fluids, enriched with volatile components containing volatile macro-element compounds, can exist. The fluids entering into the lithosphere can give off metals in the virgin form, for example, according to the reaction $Mg(C_2H_5)_2 + H_2 \rightarrow Mg + 2\ C_2H_6$. At this stage volatile agents, like C_2H_6, must arrive in the environment. Metals, accumulated in the areas of crust fractures, can oxidize, combust, and explode with time depending on local conditions [1,4]. This metal metamorphism is the cause of various natural phenomena, including earthquakes and volcano eruptions. There exist macro- and microxidizers of metals. The first comprise O_2 and H_2O, and microxidizers are S, halogenides, their derivatives, and others. One can divide the products of these processes arriving into the environment into the primary and secondary ones. Oxides, sulphides, halogenides, and others, as well as H_2 which is released according to the reaction $2K + H_2O \rightarrow K_2O + H_2$, should be classified as to primary products. The products of surrounding rock degassing which takes place at heating and melting of rocks (Rn, Ar, etc., microelements which have volatile forms under these conditions) should be assigned to the secondary products.

It is shown that the arrival rate of all the above products into the environment does not correlate with time of earthquake shocks. Obviously, the cause of seismic phenomena is not connected with tectonics but due to oxygen deficiency and the presence of metals in the mantle. In [1,4], some data, in favour of this relation, are given. For example, during interplate earthquakes there is no close relation between the direction of the tectonic forces and crust rupture. Focal earthquake areas were noticed down to the depth of about 700 km where there are no plates. It is difficult to explain the arising of infra sounds, disturbances in geomagnetic field and ionosphere, changes in the electric conductivity of rocks during earthquakes, as well as the dependence of the number of earthquakes on the Caspian water level by the tectonics of plates.

The aim of this paper is an analysis of element compositions of the samples collected at the objects situated near the earth crust deformations. The results of this study are given in Table 1. The data show that unlike surface waters, SW, Cheleken thermal waters (brines), ChW, situated at crust fractures (East Caspian sea), possess higher values of the enrichment factor, Φ, of elements, Z, relative to basalts (ultrabasites, W-1), $\Phi = (K_Z/K_{Ni})_W/(K_Z/K_{Ni})_B$. Here Li, Na, K, Rb, Cs, Mg, Ca, Sr, Ba, and Al and elements with volatile forms (halogenides) are present. The heavy elements, Cu, Fe, and Ni, which do not have stable volatile halogenides have equal values of Φ in ChW and SW, however.

The results of analysis of element compositions of hard materials, M, related to regions with earth crust deformations were obtained as well [4]. The factors of enrichment of these materials with the elements, Z, $\Phi = (K_Z/K_{Fe})_M/(K_Z/K_{Fe})_B$ are given in Table 1. The lamproites LA and LM were considered as that kind of materials. The former originated during explosive processes and the latter during the quiescent ones. Other materials are the products of volcanic activity – volcanic ashes, VAsh, sampled during the eruption of Tolbachek, and aerosols, VA, sampled from the fumarols and gryphones of volcanoes Avachinskiy and Bulgadakskiy, respectively.

All the above materials are enriched with respect to basalts with alkaline and alkaline-earth elements like ChW. Moreover, LM and VA, formed during less potent processes and have $\Phi > 1$ for Zr, Nb, Cu, and Ni which form volatile halogenides and sulphides. Obviously, LM and VA arose during the processes where S, halogenides and their derivatives play the role of the oxidizers of macrometals. However, LA and VAsh do not contain a relative excess of elements with nonvolatile oxides or hydroxides, among them Zr, Nb, Cu, and Ni. These products of more potent processes were obviously formed in the presence of macroxidizers $O_2(H_2O)$.

The data of Table 1 correlate with the physicochemical but not tectonic nature of seismic phenomena.

References

1. Chuburkov Yu.T.// Preprint JINR, P12-92-221, Dubna, 1992, p.30.
2. Chuburkov Yu.T.// Radiochemistry 1999, 41, No.5, p.409-415. Preprint JINR D12-98-180, (in English) Dubna, 1998. p.14.
3. Chuburkov Yu.T.// Preprint JINR, D12-99-110, Dubna, 1999, p.19 (in English).
4. Chuburkov Yu.T. // Preprint JINR, D12-99-320, Dubna, 1999, p.12 (in English).

Table 1

Factors of enrichment, Φ, with elements, Z, of materials, M, sampled from objects situated close to deep earth crust deformations relative to basalts, B

Z	Waters, W		Lamproites, L		Volcanoes, V	
	ChW*	SW	LA	LM	VAsh	VA
Li	138	0.5	1.3			
Na	432	0.3	1.4	0.5		
K	7	3.5	5.5	13.0	11.1	3.6
Rb	1.0	0.3	4.9	15.3	1.4	18.0
Cs	13	0.7	6.0	14.0		
Mg	5	0.8	2.0	3.7		
Ca	17	1.5	0.6	0.8	1.3	0.4
Sr	300	3.6	3.2	15.2	1.6	3.7
Ba	8**	1.9	54.6	28.0		
Zn	8	1.0	0.7			
Cd	582	303				
Al	4.4	0.02				
La			0.4	13.0+		
Lu			0.2	0.3+		
Tl	355	188				
Zr			1.0	15.5		5.2
Pb	107	4	0.8	8.3		
Nb			0.7	12.7	1.1	9.7
Cu	0.6	0.8	0.5			69.0
Fe	0.02	0.07	1	1	1	1
Ni	1	1	3.6	9.1	0.9	4.0

* – bore holes Г-14 and Г-152

** – not accounting for $BaSO_4$ sediment.

\+ – it is difficult to explain different behavior of La and Lu, see [4].

DYNAMICS OF SUB-SOIL RADON WITHIN THE GEO-DYNAMICALLY ACTIVE REGIONS OF TURKMENISTAN

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This information deals with the study of sub-soil radon dynamics in the Kopetdag and Balkan seismo-active regions of Turkmenistan. The considered sector of Alpine folded system is characterized by complicated geological and tectonic composition, and is distinguished by its high interior seismic activity. Obviously, for a certain extent these factors are responsible for the high radon content within the near-surface air over the Turkmenistan territory, where, according to the data of remote measurements of radon concentrations (Boltneva L.I., Popov V.A., et al., 1980), the average gas content within the 300 m layer of the atmosphere is several times higher as compared with the concentration over the European territories of Russia and other CIS regions.

At the observation points radon concentration is measured by the passive method (without forced sampling), with the help of the installation registering beta radiation of the products of radon decay, recording the measurement results on the recorder's tape. For the combined analysis of the results of emanation investigations at the observation points the measurements of the concentrations of sub-soil hydrogen have been simultaneously carried out.

Radon concentration is extremely instable both in space and time. Radioactivity of rocka, peculiarities of the earth crust composition, geodynamic activity of the regions interior affect the gas background values. The increased values of radon concentration are registered over zones with tectonic active structures. Especially high variations of sub-soil radon within such zones are observed during the period of intensification of geodynamic processes. Background values, amplitude, the period and other parameters of the time radon series have been changed.

The analysis of time alterations of concentrations of sub-soil radon within Ashkhabad, Kopetdag and Balkan seismic active regions has shown the alteration of its average background level. Recently at the points of measurement of sub-soil radon concentration the increase (insignificant) of its background values has been registered. Hereto the velocity of alteration of the background level of sub-soil gas is small. The analogous running (alteration of the background value) is observed either within the time series of sub-soil hydrogen. These typical peculiarities of the time alterations of radon and hydrogen fields of the sub-soil atmosphere, reflect the intensification of discharge of the natural gases into the sub-soil atmosphere and the near-surface troposphere within seismic active regions of Turkmenistan. One can suppose that variations of intensity of radon flow into the sub-soil atmosphere and the near-surface troposphere re the signs of alteration of geodynamic situation within the Turkmenistan sector of the Alpine folded system.

POTENTIALITIES OF BACTERIAL LEACHING FROM LEAN ORES, ROCKS AND INDUSTRIAL WASTES IN GEORGIA STUDIED BY NEUTRON ACTIVATION

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An ever-growing need in different metals demands efficient and, at the same time, inexpensive methods of their extraction from lean ores, rocks and mining-processing industrial wastes. Intensively developing methods of bacterial leaching for ores deal mostly with the extraction of a limited number of metals to be found in substrates at more or less increased concentrations. An attempt to study the technological process of bacterial leaching of a wide range of rare and scattered elements contained at low concentrations in lean ores, rocks and industrial wastes in Georgia was undertaken by instrumental epithermal neutron activation analysis at the IBR-2 reactor, FLNP JINR, Dubna. The elemental content of the initial samples and their leachates determined with a high accuracy and precision allowed us to assess the results of a specific bacterial leaching procedure developed in the Georgian Technical University. The results of this study showed that the developed technique based on a specific microbial community (natural peat bog) increases substantially the potential of applying the bacterial leaching targeting in metal extraction, ores and rocks enrichment as well as in wastes purification from toxic metals, etc. The suggested technique of metal extraction and waste purification is of great potential especially for uranium, rhenium, selenium, cadmium, strontium, samarium and a few more, including gold, thorium, indium, scandium, tantalum, rubidium and lanthanoids: terbium, lanthanum, ytterbium, lutetium, neodymium and erbium. The present study characterises the behaviour of 56 elements contained in the composition of different ores, rocks and industrial wastes in Georgia.

THE CHEMICAL PARAMETERS OF MUD VOLCANO WATERS MEASURING

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Many heavy and light metals and their combinations were measured in mud volcano waters in the chemical laboratory of the Krasnodar Technics School. Simultaneously, U, Th and K using a low background underground spectrometer were defined in clays of mud volcano. The spectrometer includes the crystal NaI(Tl), 100X100 mm, with a well and a photomultiplier tube and a metallic absorber, electronic circuit and a high-voltage source. The photo-calorimeter' method is employed to determine the elements Zn, Cu, Hg, Pb, Ni, Mn, Cr, Ac, Fe, NO_2, NO_3, SO_4, Cl, CO_2, I, F, Ba in water.

The activity of the mud volcano was determined by gas quantity.

The obtained data show that the concentration of heavy metals decreases as the volcanic activity grows. On the other side the light metals concentration rises as the mud volcano activity increases. In addition, the concentration of soil hydrogen over mud volcano territory is investigated. The concentration of hydrogen is lower near high gas and water exits.

The obtained data for two volcano, " Shapsugsky" and "Shugo" , are shown.

RADIOISOTOPES IN LIFE SCIENCES. THE PRODUCTION OF HIGH PURITY SOURCES AT FLNR JINR

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The FLNR accelerators - cyclotron U-200 and microtron MT-25 - represent an important resource for the production of a wide variety of man-made radioisotopes for special biomedical and ecological researches.

A short review of the current data for nuclear reactions, targets, radiochemical and electromagnetic separation methods and applications of some radioisotopes as tracers is given in this report.

Preparation of carrier free high purity radioisotopes of ^{26}Al and ^{237}Pu for metabolism studies, **(1)**; ^{97}Tc, ^{236}Pu, ^{235}Np and ^{236}Np for environmental researches, **(2)**; $^{99}Mo/^{99m}Tc$, ^{149}Tb, ^{186}Re, ^{211}At and $^{225}Ac/^{213}Bi$ for labeling of different compounds, **(3)**, was developed:

Group	Isotope	$T_{1/2}$	Reaction	E,MeV	Thick target yield, Bq/μAh
1	^{26}Al	7.2×10^5 y	$Mg(^4He, pxn)$	35→15	0.4
	^{237}Pu	45.6 d	$^{235}U\text{-}235(^4He,2n)$	27→24	3.12×10^3
2	^{97}Tc	4×10^6 y	$^{95}Mo(^4He,2n)$	36→14	0.06
	^{236}Pu	2.86 y	$^{235}U(d,n)$	18	22
			$^{235}U(^4He,3n)$	36→30	34
			$^{237}Np(\gamma,n)$	25	48
	^{235}Np	391.1 d	$^{235}U(d,2n)$	18	330
	^{2361}Np	1.54 y	$^{237}Np(\gamma,n)$	25	
3	^{99}Mo ↓	66 h	$^{100}Mo(\gamma,n)$	25	2×10^3 /mg ^{100}Mo
	^{99m}Tc	6 h			
	^{149}Tb	4.1 h	$Nd(^{12}C,xn)$	108→90	4×10^6
	^{186}Re	89.25 d	$^{186}W(d,2n)$	18	7.4×10^6
	^{211}At	7.2 h	$^{209}Bi(^4He,2n)$	30→10	2.8×10^7
	^{225}Ac ↓	10d	$^{226}Ra(\gamma,n)$	25	5×10^2/10mg ^{226}Ra
	^{213}Bi	45.6 m			

The main attention was devoted to the production of ultra pure ^{237}Pu, ^{236}Pu and ^{235}Np which are convenient isotopes as tracers in the determination of the plutonium and neptunium content in environmental and biological samples. Besides, ^{237}Pu is the only plutonium isotope which meets the medical requirements of the metabolism research *in vivo*. Depending on the required purity a ^{237}Pu specimen was subjected to one or two stages of mass separation after chemical procedures. Plutonium-237 obtained after the second mass separation was the purest reported to date and it was in use to measure hepatite accumulation, clearance from blood and excretion following intravenous injection.

ON DETERMINATION OF RADIOACTIVE CONTAMINATION AND GEOCHEMICAL PROPERTIES OF THE OB AND YENISEY ESTUARY SEDIMENTS

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Radioecological conditions of the Kara Sea are determined by the effect of various radioactive contamination sources: tests of nuclear weapons at the Novaya Zemlya Islands; discharge of liquid radioactive wastes to the sea, dumping of containers with radwastes and used-up reactors of submarines; global fall-out of radionuclides from the atmosphere.

In the upper course of these rivers the warhead plutonium producing plants, as well as nuclear reactor manufacturing works and spent nuclear fuel processing plants are located: namely, PO Mayak in Chelyabinsk-65, Sibirsky Chemical Operations in Tomsk-5, Mining and Chemical Operations in Krasnoyarsk-45.

Estimation of the difference in geochemical characteristics of various bottom sediments of the Ob inlet and Yenisey estuary was effected through the comparative related samples. The sample for the Ob inlet consisted of 72 specimens (4 stations), the sample for the Yenisey estuary also consisted of 72 specimens (3 stations). Each sample was represented by the results of the analysis of 23 trace elements (data are in ppm), three major elements as content of their oxides in weight % (INAA analysis), as well as ^{137}Cs and ^{40}K isotopes in Bq/kg (gamma-spectrometry analysis)

The samples of the Ob and Yenisei sediments have an over 1.5-fold difference in the mean values of ^{137}Cs, CaO, Br, As, Sb, Sr, Cs. U content and in ^{137}Cs, Br, Hf, U standard deviations, as well as a nearly 1.5-fold difference in the mean values of Rb, La, Ce, Th content and in As, La, Sm, Yb, Ta standard deviations. In this case, major part of the registered values of As and Sb content are outside the threshold sensitivity.

A substantial difference in the mean values of ^{137}Cs concentrations is determined by the presence of several specimens with abnormally high concentrations of this artificial isotope in the Yenisei sample, while its background distributions are rather similar. Excessive concentrations of natural Cs isotopes, as well as other elements were not practically registered, however their background distributions differ greatly primarily in a clearly demonstrated shift of their centres. The form of concentration distributions is close to a normal one for all natural components under consideration in the Ob sample. In the Yenisei sample such components as Fe_2O_3, La, Ce, Th clearly demonstrate the polymodality of their content value distribution. A polymodal form of the distribution is expected for ^{137}Cs, and it is more brightly indicated in the Yenisei specimens, as compared to those from the Ob.

The main difference between the sediments of the Yenisei and Ob estuaries in the ^{137}Cs vertical distribution is in the fact that for the former, a more even and gradual growth and decline of element content by layers with the growth of the depth and substantially higher concentrations (up to 260 Bq/kg) are more typical. Probably, this difference can be explained by the fact that the mineral composition of bottom sediments in the investigated areas is not uniform. For the sediments of the Yenisei estuary a high content of clay minerals and a lower variability of different lithological types in the section increasing the sorption capacity, are more typical. However, clearly demonstrated geochemical heterogeneity of the Yenisei sediments with their lower lithological variability as compared to the Ob sediments might prove the difference in geological and geochemical conditions of the areas of the continental run-off from the Yenisei River basin.

DATING OF RADIATIONAL CONTAMINATION OF A LOCALITY IN SOUTHERN REGIONS OF WESTERN KAZAKHSTAN

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In the report there are presented: a) the method for determination of thr date (year) of contamination of a locality by alpha-radiators [1]; b) results of application of the method for Southern regions of Western Kazakhstan.

Briefly, the gist of the method consists is to process the surface of a tree grown in the investigated locality, there is used nuclear photoemulsion. An exposure lasts about (1,5÷2) months. In the developed emulsion, with the help of a microscope there is determined the number of traces of alpha-particles emitted by radionuclides accumulated in wood. Knowing the area and time of exposure it is possible to determine the flux density of alpha-particles — φ_i (the number of particles falling on the unit area per time unit). The calculation of the excess of the signal (φ_i) over natural and instrumental backgrounds (φ_{backgr}) by

$$\frac{\varphi_i - \varphi_{backgr}}{\varphi_{backgr}},$$

for each annual ring of the tree allows the determination of the relative level of contamination for the given locality for each calendar year within the limits of the life time of the tree, i.e. to date the radioactive contamination of the locality. The method is certified and patented [2].

The described method was used for the study of the date of radioactive contamination of different regions of Kazakhstan [3]. In this report there are presented the results of the investigation of the Southern regions of Western Kazakhstan adjoining the Test Sites "Kapustin Jar" and "Azgir". It is shown that radioactive contamination took place in the consequence of explosions at these Test Sites, global falls-out, Chernobyl accident as well as of explosions at the Chinese Test Site "Lobnor". The presented data, as well as the earlier data[4], correlate with the results obtained with the help of EPR-spectrometry.

REFERENCES

1. I.Ya. Chasnikov, A.I. Polyakov, A.Sh. Gaitinov. Preprint IHEP. 1994 (in Russian).
2. I.Ya. Chasnikov, A.Sh. Gaitinov. Bulletin of the National Patent Department, RK. №2, March 16 1998 (in Russian).
3. I.Ya. Chasnikov, A.I. Polyakov, A.Sh. Gaitinov et al. Collection of Scientific paper. Almaty-city. Edition "GNPOPE KazMechanObr". 1997. V.22. pp. 60-92 (in Russian).
4. Yu.A. Ryabikin et al. Journal "Doklady of MN-AN RK". 1998. №4, pp. 3-6 (in Russian).

RADIOECOLOGICAL ANALYSIS OF VIET NAM SOIL SAMPLES

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In Vietnam radiation monitoring of cultivated areas is being carried out with the objective of collecting radioecological information which is demanded for obtaining an estimate of radioactive pollution in the country. Series of soil samples collected in the selected areas ot Vietnam were analyzed for the presence of radionuclides:137Cs, 238U. Methods for separation of radionuclides from the samples were developed and used for control and analysis of environmental pollution in Vietnam. The data obtained by Enviromental Radioactivity Laboratory at INP, Kraków and quoted from IAEA reports were used as a reference point for the estimation of radioactive contamination of cultivated soils in Vietnam. The measurements were performed using the spectrometry method. The treatement of the spectra obtained and the required calculation were carried out with the use of the MAESTRO-32 program. The results obtained were estimated by comparision with those obtained in the vicinity of Chernobyl. The results of the soils and bay water studies are presented in the tables and spectra obtained. The 137Cs content in the soils ranges from 0.1 Bq/kg to 12 Bq/kg. The 238U content in the soils falls in the range from 1.09 Bq/kg to 23 Bq/kg. On the base of the measurement results the radioecological maps of some areas in Vietnam were drawn. It was revealed that the north-west areas in Vietnam indicate the build-up of 238 U; this fact suggests some slight deposits of that isotope in the area.

The investigation performed displays a slight level, as compared to areas in the vicinity of Chernobyl, of soil contamination by 137 Cs and 238U.

DETERMINATION OF NA-22 IN KRASNODAR RESERVOIR WATERS

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In the year 2000 we started to determine Na-22 in waters of the Krasnodar reservoir. 2000 L of water samples were picked and let pass through a big column in the form of a glass cylinder 1 m long with an ion-exchange resin. A chemical procedure was used to prepare Na-samples. With a normal coincidence method the events of the positron emitter ^{22}Na are distributed over the peaks 0.511 x 0.511 MeV and 0.511 x 1.275 MeV . A low background spectrometer operating in the laboratory is covered with 50 m of rock and consists of two crystals NaI(Tl) 150x150 mm. The preliminary results are shown in Table 1.

Picked out date	A(t) , count / min.m^3
5.03.2000	13.2 ± 1.0
5. 05.2000	8.5 ± 0.8
14.07.2000	8.1 ±0.8
22.08.2000	6.2 ± 0.6

Na-22 measurements are very important for the study of surface waters mixing for the purposes of ecology studies. The determination of the atmosphere pollution by Na-22 from the Rostov power-station is necessary.

DISTRIBUTION OF RADIONUCLIDES IN WATER AND THEIR DETECTION

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Radioactive substances are present in natural superficial waters with a very low concentration. It is necessary to note that the content of similar radionuclides in water and bottom sediments is different. Therefore, the selection of samples for analysis must be done taking into account the parameters of the water reservoir and the specifics of a particular problem.

Also, important components are elementary bio-organism in natural waters. For a constant concentration in water of long-lived radionuclides the dynamic balance is established between water and water plants. As a result, the impression is that water plants do not influence the contents of radionuclides in water. If in water there are found short-lived radionuclides instead of earlier absorbed or emitted radionuclides, the plant absorbs new. Thus, some part of radionuclides can pass from plants back to water. In rivers this does not play an essential role, but in ponds and lakes this can have an essential meaning as a factor of secondary pollution.

The paper describes the determination of radioactivity in water in the investigation of the conditions of receiving and distribution of radionuclides between appropriate components depending on structure and properties of water, and the degree of development of waters flora and fauna in it.

SOME NATURAL AND MAN-MADE RADIONUCLIDE PROFILES IN THE BOTTOM SEDIMENTS OF THE BLACK SEA

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The main three sources of radionuclide contamination of the Black Sea are atmospheric fallouts after nuclear tests (with maximum in early 60s), accident at the Chernobyl NPP (1986) and possible contamination due to contemporary activities of some European countries in the nuclear field.

The global radionuclide fallout as a result of nuclear weapon tests in the atmosphere can be obtained everywhere in bottom sediments from 1952-1953 with a maximum corresponding to the early 60s caused by intensification of tests. Then the a smooth recession is observed after the prohibition of the nuclear weapon tests, except for underground.

After the accident at the Chernobyl NPP two main paths of radionuclides supply were observed. During the first weeks after the accident the main part of fission products were supplied with atmospheric fallout. Later radionuclide supplies were rivers, mainly the Dnieper and the Danube.

The aim of this work is to study the vertical profiles of radionuclide concentration in the bottom sediments of the Black Sea with man-made radionuclides, to study the history (by age-dating of sediment cores) and to trace a possible source of radionuclide contamination.

The bottom sediments were collected in the Danube river avandelta, the Dnieper-Bug gulf and in the Gelendzik gulf. Non-destructive HPGe spectroscopy was used to determine γ-emitting radionuclides (^{137}Cs, ^{40}K, radionuclides of ^{238}U and ^{232}Th chains). For age-dating of sediment cores the ^{210}Pb activities were determined by LSC after the sample digestion and chemical separation. The ^{238}Pu, $^{239,240}Pu$ were determined by α-spectroscopy and ^{241}Pu by LSC.

The vertical distribution of man-made radionuclides in the collected bottom sediments was significantly different. In the vertical profile of ^{137}Cs in the sediment samples collected in the Gelendzik gulf a maximum activity caused by intensification of nuclear weapon tests in the beginning of the 60s is observed with a smooth recession. A maximum ^{137}Cs activity corresponds to the Chernobyl accident (1986) and is observed in the 4-5 cm horizon as well.

For the sediment cores collected in the Dnieper-Bug gulf the highest ^{137}Cs activity was found in the upper horizon with a smooth recession to the background level. The results of ^{210}Pb age-dating of this column show sufficient mixing of sediments possibly due to spring floods.

Analogous sediment mixing was found for samples collected in the Danube river avandelta. In order to determine the source of radionuclide contamination Plutonium isotopes ratios could be used. For both upper and deeper cores of the sediment the decay corrected $^{238}Pu/^{239,240}Pu$ and $^{241}Pu/^{239,240}Pu$ ratios provide an indication of the Chernobyl origin of the radionuclides.

Non-Destructive Method of Pu and U Isotope Determination in Specimens

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ABSTRACT

Now it is determined, that plutonium concentration in upper layer of soil (0-30cm) is about 10^{-13} gram of Pu per gram of soil Central and Eastern Europe countries.
At present the man-made transuranium elements created as a result of nuclear weapons tests or due to accidents on nuclear power plants are widely distributed on the surface of the Earth. Plutonium is the most widespread element among TSE and is represented as alpha- and beta-emitter. Although the average concentration of plutonium is about 10^{-13} g/g in the environment, it is considerably higher in the contaminated regions.
The appearance of plutonium in the geo- and biosphere is a relatively new problem in trace analysis, so its geobiochemical behaviour in the environment has been studied insufficiently at present.
The investigation of the plutonium content with the radiochemical separation and alpha-spectrometry is rather difficult. Besides, as a result of a chemical treatment the information on its microdistribution in the specimen is lost. We are proposed a non-destructive method of Pu determination in solids, allowing to avoid these difficulties.
It is based on ^{239}Pu determination in specimens using combined neutron and gamma-activation analysis.
This method can be used for the quick, high-sensitive and inexpensive Pu estimation in the areas heavily damaged due to radioactive fall-out. The sensitivity of proposed method lies between 10^{-9}-10^{-11} g/g. Some modifying of this method made it possible to identify "hot" particles of the Chernobyl area.

ROLE OF RADON IN A COMPLEX RADIATION-HYGIENIC ESTIMATION OF KINDERGARTENS

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In the early age a young organism forms and develops all vital functions which later determine the vital potential of an adult. The growing organism of the child is more subjected to the negative influence of various factors including the radiation factor. As children spend a significant part of their time in kindergartens, it is not only necessary to provide their comfortable stay but also normal radiation-hygienic conditions. One of the components of the radiation influence is the radiation dose received from radon-222. In the city of Tomsk monitoring of radon levels in the rooms of kindergartens was carried out. Measurements of the radon concentration in the air were realized using solid state nuclear track detectors. The duration of one measurement was 1 - 2 months. Another effort was directed on the collection of statistical data, necessary for an accurate estimation of the received dose. The data include the average annual time a child spends in the kindergarten (in view of holidays and time of preventive maintenance), outdoors, etc. Place of the kindergarten, constructional features of the building, conditions of ventilation are also important. The experimental and theoretical results and their discussion are in the report.

MONITORING OF RADON DECAY PRODUCTS

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Measurements of the radon concentration in air can be performed by a variety of passive and active radon dosimeters. However, the radiation induced damage of the human respiratory tract is mainly the result of short-lived radon daughters characterised by potential alpha energy concentrations. Thus, the estimation of radiation exposure of the public requires long-term measurements of a potential alpha energy concentration of radon daughters during a period of some months. Since such measurements are difficult in most cases, the potential alpha energy is calculated from the measured radon concentration accepting an appropriate equilibrium factor F ($F = W/W_{eq}$, where W is the total potential alpha energy of an actual daughter mixture and W_{eq} is the total potential alpha energy concentration of radon daughters in equilibrium with radon). The equilibrium factor can be estimated by means of short-term measurements of the radon daughter concentrations of ^{218}Po and ^{214} Po. Short-term measurements of radon and radon decay product concentrations in air can be performed by a variety of active techniques. However, the accepted F is not representative for longer periods of time.

In the present communication the theoretical basis of radon daughter measurements using a purely passive system of etched track detectors are summarised. The behaviour of radon decay products in air is explained. The basic processes involved are the attachment to atmospheric aerosols, plate-out, recoil from surfaces, and decay. Various techniques for radon decay product measurements using etched track detectors are discussed. Special attention is paid to the representation of the technique developed in our laboratory. This technique is based on a combination of alpha particles autoradiography and alpha particles spectroscopy with a CR-39 detector. The outstanding characteristics of the techniques are high sensitivity (the detection limit for deposited radon decay products is 100 atoms/cm^2), high position precision for deposited decay products (2 μm) and a high energy resolution of alpha particles (0.1 MeV).

LOW ACTIVITY BETA-ALPHA RADIOMETER (LABAR)

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The LABAR is intended for sensitive measurements of low β and α radioactivity from various kinds of samples. The instrument could be supplied with an automatically changing sample device. Gas flow proportional counters are used both for measuring and shielding of detectors. The counters are fed in series with a mixture of Ar/CH_4. The background due to cosmic radiation and the natural gamma background are reduced additionally by lead and copper shielding.
For low α radioactivity spectroscopic measurements an option of the silicon surface-barrier detector could be used.
All the detectors are in conjunction with a computer system for on-line storage of data.
The applications are:
- Environmental survey.
- Sanitary control.
- Health physics.
- Industrial safety.
- Agricultural research.
- Radiochemistry and Physics.
- Radon emission control.

INVESTIGATION OF RADIOISOTOPES IN MERCURY PLANT PRODUCTION

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Measurements of some stable and radioactivity elements over the Krasnodar mercury plant territory are described. Work began in 1999. The following measurements were conducted:

- radon in air, in soil, in gallery and in the rooms of the plant. Continuous measuring of Rn-variations are recorded every 5 min;
- gamma-isotopes determined in soil in the territory of the plant. U, Th and K are determined;
- measuring of mercury in the regions waters every hour in the course of 3 days;
- chemical analysis of the elements Zn, Cu, Pb, Ni, Mn, Cr, Ac, Fe, NO_2, NO_3, SO_4, CO_2, Cl, F, I and Ba in waters and soil.

Data on changes in radioactivity and stable elements in time are adduced. The map of the elements distribution over plant territory is shown.

Moreover spontaneous transitions of mercury nuclei in the superdense state were investigated.

The amount of environmental mercury around the gallery is several hundred tons. An anomaly of γ-rays radiation up to 26 MeV in the underground gallery "Sachalin" (Krasnodar region) was found. The crystal NaI(Tl) 150x100 mm, and anticoincidence plastic scintillators 50 mm thick were placed in the mercury gallery at the depth 25 m. The underground setup has been operated since 1999. The background spectra are shown. Some anomalous " bursts" in the high region of γ-rays is discovered.

FISSION OF THE Pb NUCLEI INDUCED by E>0,5 GEV/AMU p,d, He and ^{12}C PROJECTILES IN THE VOLUME OF MASSIVE Pb,Hg AND U TARGET

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Series of experiments with relativistic protons, deuterons, helium and carbon-12 projectiles accelerated at synchrophasotron LHE, Dubna which hit massive Pb and U targets was carried out using SSNTD. The beam profiles and intensities of both primary particles and secondary fast neutrons were measured inside the massive cylinder blocks of Cu, Pb and U by counting of fission fragment track due to the induced fission of Pb nuclei. The beam diameter typically increases by 20-30% at the depth 10 and 20.cm. With increasing the energy of projectiles the number of secondary neutrons rises with the depth for protons, deuterons and helium ions. Nevertheless for ^{12}C ions beams with changing the energy from 18 GeV to 44 GeV we first observe the effect of significant increase both the yield of secondary fast neutrons and the half-width of the beam.

The observer enhanced yield of secondary fast neutrons strictly and definitely and definitely confirms unusual behaviour of nuclear interaction cross section of 44 GeV ^{12}C ions observed earlier in our studies with massive blocks of Cu, Pb and U.

BIG MULTIWIRE PROPORTIONAL CHAMBER FOR THE DETECTION OF T, CL-36, KR-85 AND UNCOMMON NUCLEUS IN NATURE

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We started the determination of many isotopes including tritium, Cl-36, S-32 and Kr-85 in the Krasnodar territory in 1999. The measurements were conducted for the purposes of ecology and geochemistry. Tritium measurements are very important for underground and surface water mixing research. The age of ground waters may be determined by Kr- 85 very exactly. Moreover the atmospheric pollution from the Rostov nuclear power-station may be determined with Kr-85. The preliminary data on the Kr-85 concentration in the mixture of inert gases from the oxygen plant are 0.7 Bq/ m^3.

For an exact determination of these isotopes a low background chamber in the underground gallery at the depth up 50 m is created in Novorossyisk.

To decrease the background and have a high sensitivity multiwire proportional counter is under operation. The volume of the chamber is 30 l. The pressure may reach 50 atm. The technical characteristics of the counter are: diameter of the body - 200 mm; length of the counter - 800 mm; cathode Ni-Cr alloy, 0.02 mm; anode -tungsten 0.01 mm. The step of cathode wires is 5 mm, the step of anode wires is 10 mm. The model with the volume 3 l with copper walls is made.

The characteristics of the counter are shown.

DETERMINATION OF THE DIFFUSION COEFFICIENT OF IN, CD, ZR, HF AND PU HYDRATED IONS IN WATER SOLUTIONS USING THE METHOD OF HORIZONTAL ZONE ELECTROPHORESIS IN A FREE ELECTROLYTE

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The method of determination of the diffusion coefficients of ions in aqueous solutions using a device for horizontal zone electrophoresis in a free electrolyte is described. The diffusion coefficients of Cd(II), In(III), Zr(IV), Hf(IV) and Pu(VI) in aqueous solutions are determined.

ADVANCED RESEARCH WORKSHOP

Monitoring of Natural and Man-Made Radionuclides and Heavy Metal Waste in Environment

Рабочее совещание «Измерение содержания природных и техногенных радионуклидов и тяжелых металлов в окружающей среде»

E14-2000-225

Ответственные за подготовку сборника к печати
В.П.Перелыгин, В.М.Фронтасьева

Макет Т.Е.Попеко

Рукопись сборника поступила 27.09.2000. Подписано в печать 28.09.2000
Формат 60 × 90/16. Офсетная печать. Уч.-изд. листов 8,64
Тираж 185. Заказ 52257

Издательский отдел Объединенного института ядерных исследований
Дубна Московской области