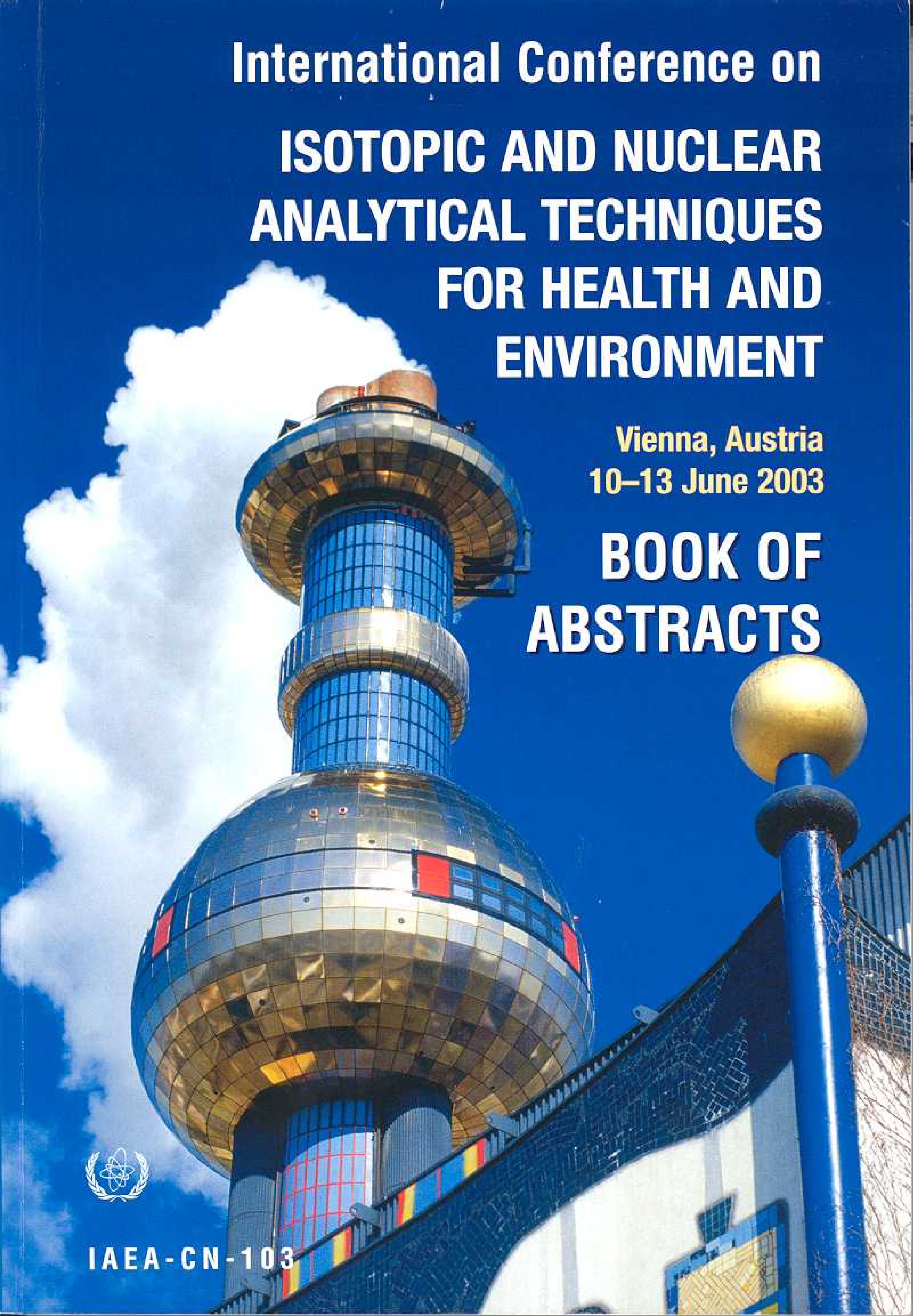

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BOOK OF ABSTRACTS

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CONTENTS

ORAL PRESENTATIONS

IAEA-CN-103/

004 Study of Organohalogens in Foodstuffs and Environmental Samples by Neutron Activation Analysis and Related Techniques 1
Z.F. Chai, D.D. Xu, W.K. Zhong, X.Y. Mao, H. Ouyang

008 Radioactive Monitoring at Jakarta Bay and Muria Coastal Zone in Indonesia 2
H. Suseno, H. Umbara

013 Heavy Metals Inputs in Northern Patagonia Lakes from Short Sediment Cores Analysis 3
S. Ribeiro Guevara, A. Rizzo, R. Sánchez, M. Arribére

019 Use of D-T Produced Fast Neutrons for *in vivo* Body Composition Analysis: a Reference Method for Nutritional Assessment in the Elderly 4
J.J. Kehayias

023 Simultaneous Determination of Radionuclides Separable into Natural Decay Series using Time Interval Analysis (TIA) 5
T. Hashimoto, Y. Uezu

025 The Internal Comparator Method in INAA 6
X. Lin, R. Henkelmann

026 Elemental Contents in Napoleon's Hairs cut before and after his Death: did Napoleon die from Arsenic Poisoning? 7
X. Lin, D. Alber, R. Henkelmann

028 Utilization of Stable Isotope, ^{26}Mg, for Investigating the Cause of Sudden Death 8
M. Chiba, A. Shinohara, Y. Inaba

032 Use Tracer Technique to Investigate the Dependence of Soil-to-Plant Transfer Factor of Sr and Cs on the Type of Soils 9
Nguyen Hao Quang, Dang Duc Nhan, Pham Van, Vu Thuy Nga

034 Nutrient-Pollutant Interactions and their Potential Implications on Human Health 10
R. Gross, K. Gross, G.V. Iyengar

037 Metrological Assessment of the High-Accuracy RNAA Method of Co Determination in Biological Materials 11
H. Polkowska-Motrenko, B. Danko, R. Dybczyński

039 Application of Nuclear Microprobe Techniques in the Analysis of Biological Materials 12
S. Kumar, V.S. Raju

041 Glucose Tolerance by $^{13}CO_2$ Breath Test Methodology and Utilization 13
Z. Latif, M.A. Tasneem, M. Ali, M.I. Sajjad, W.A. Coward

046 The TDCR Method as an Important Tool in Radionuclide Metrology 14
R. Broda, K. Małetka

055 Monitoring of Ground Level Air in the Framework of Trace Analysis: Methods and Results 15
J. Bieringer, C. Schlosser

056 INAA Applications in the Assessment of Minor and Trace Element Contents in the Soil of Moscow's Park 16
D.Zaichick, N. Dogadkin, V. Zaichick

057 Regulatory and Scientific Aspects of Environmental Studies 17
R. Ladygienė, G. Morkūnas, L. Pilkytė

060 Multiple Techniques used for Radiological Characterization of the Magurele Fortress - Battery 14-15, Romania 18
L. Biro, C. Garlea, I. Garlea, N. Heredea, C. Kelerman

062 Provenance Study of Amerindian Ceramic Figurines with PGNAA 19
M. Antczak, Zs. Kasztovszky, A. Antczak, L. Sajó-Bohus

063 The Current Status and Further Development of the Nuclear and Isotope Analytics in an Industry (Ecological Aspects) 20
V.P. Varvaritsa, E.R. Kartashev, N.R. Kuzelev, A.S. Shtan

070 Assessment of Drinking Water Radioactivity Content by Liquid Scintillation Counting: Set-up of High Sensitivity and Emergency Procedures 21
R. Rusconi, M. Forte, S. Bellinzona, R. Gallini, G. Sgorbati

071 Determination of ^{210}Pb in Environmental Samples Following Different Procedures 22
C. Gascó, M.P. Antón, R. García, D. Pérez

072 Naturally Occurring Radionuclides in Thermal Swimming Pools of the Slovak Republic....23
A. Ďurecová, D. Bursová, F. Ďurec

074 Development of a Prompt-Gamma Neutron Activation Analysis Facility for Small Animal *In Vivo* Body Composition Studies using Am-Be Source 24
E. Stamatelatos, K. Kasviki, S. Green, M. Gainey, J. Kalef-Ezra, A. Beddoe

075 Large Sample NAA Facility at GRR-1 Research Reactor: Design and Applications 25
F. Tzika, I.E. Stamatelatos, J. Kalef-Ezra, P. Bode

076 Investigation of Trace Element Atmospheric Pollution by Nuclear Analytical Techniques at a Global Scale: Harmonized Approaches Supported by the IAEA....................................26
B. Smodis

081 Use of Milk Progesterone RIA for the Monitoring of Artificial Insemination of Dairy Cows on Smallholder Farms in Turkey 27
I. Tosun, H. Ozcan, N. Cetinkaya

083 Improving Tritium Exposure Reconstructions Using Accelerator Mass Spectrometry..........28
A.H. Love, J.R. Hunt, J.P. Knezovich

085 Air Radon Concentrations in Tunisia - A Preliminary 29
M.V. El May, N. Chahed, S. Mtimet

086 Behaviour of Gammaemitters, Sr-90 and Transuranic Elements in Forest Environment.......30
T.K. Ikäheimonen, S. Klemola, E. Ilus

088 Occupational Monitoring Programme of Uranium Concentrate Unit in Caetite, Brazil: Bioassay Programme 31
D.A. Py Junior, W.S. Pereira

089 Monitoring of Ra-226 an Ra-228 in Manioc (*Manioht utilissima*) and it's Flour in Uranium Mining in Caetité - Tropical Area in Brazil..32
W.S. Pereira, D.A. Py Junior

091 Determination of Metals and Gamma Radioactivity in Marine Algae from the Venezuelan Central Coast...33
L. Sajo-Bohus, D. Palacios, J. Castillo, J. Bermúdez, E. Greaves

095 Instrumental Neutron Activation Analysis of Biological Materials using Research Reactors at BARC 34
R. Acharva, A.G.C. Nair, A.V.R. Reddy, S.B. Manohar

096 Environmental Monitoring of Radioactivity Level in Qarun Lake 35
A.E.M. Khater, M.S. El Tahawy

101 Assessment of Occupational Exposure to Toxic Metals in Some Paint and Secondary Iron and Steel Industries in Lagos, Nigeria using TXRF Technique 36
H.B. Olaniyi, I.B. Obioh, O.K. Owoade, F.S. Oliseh

103 Studies on Mercury Contamination in the Brazilian Amazonic Region using Neutron Activation Analysis and Atomic Absorption Spectroscopy 37
M.B.A. Vasconcellos, M. Horvat, M.G.M. Catharino, G. Paletti, M. Saiki, D.I.T. Fávaro, R. Baruzzi, D.A. Rodrigues

106 Instrumental Neutron Activation Analysis in Geochemistry. Emphasis on Spectral and Uranium Fission Product Interferences 38
M.D. Tshiashala, G. Erdtmann

108 A Competitive Method for simultaneous Deuteron-Cyclotron Production of No-Carrier-Added Copper-64 and Gallium-67,66 for Applications in PET Radiodiagnostic and Metabolic Therapy of Tumours 40
F. Groppi, M. Bonardi, C. Birattari, C.H.S. Mainardi, E. Menapace

109 Uptake, Retention and Organic/Tissue Distribution of ^{137}Cs by Japanese Catfish *(Silurus asotus linnaeus)* 41
M.A. Malek, M. Nakahara, R. Nakamura

113 Radiomonitoring of Radon in Seismoactive Zones of Azerbaijan 42
T.A. Zolotovitskaya

115 Analytical Quality Assurance/Quality Control of Nuclear Techniques within RER/2/004 43
P. Arikan, O. Acar, R. Acar, G.A. Aycik, M.A. Cetiner, H. Demirel, N. Efe, T. Golge, R. Gurellier, R. Kirmaz, S. Tulumen, H. Yucel, A. Zararsiz, Y. Agus

116 Intakes of Radiologically Important Trace Elements from Iranian Daily Diets 44
A.G. Gharib, S. Fatoorehchian

119 Sr-90 in Various Food and Foodstuffs 45
U. Repinc, L. Benedik, R. Jakopič

120 IAEA Initiatives in Body Composition and Breast Milk Determination: Examples from Ghana and Senegal 46
N. Mokhtar, B. Miranda-da-Cruz, V. Iyengar

123 Advanced Nuclear Techniques for Health and Environment 48
C. Tuniz

125 Application of X ray Fluorescence Techniques for the Determination of Hazardous and Essential Trace Elements in Environmental and Biological Materials 48
S.A. Bamford, D. Wegrzynek, E. Chinea-Cano, A. Markowicz

127 The Affectivity of Applying New Isotope Methods and Radiation Biogeocenology in Defining the Migration and Space Allocation of Radionuclides 49
I.Sh. Normatov, U. Mirsaidov

128 Use of PIXE, PIGE, XRF for the Decision of Ecological Problems in the NSC KIPT 51
V. Levenets, V. Lapshin

129 Investigations of some Core and Surface Sediments from the Black Sea by Radioisotope Excited EDXRF and INAA Techniques 52
T. Akyuz, S. Akyuz, O. Algan, N.M. Mukhamedshina, A.A. Mirsagatova

136 Improving Food Safety with accurrate Analysis by Laboratories participating in Proficiency Testing Programmes 53
E. Cortés, N. Gras

140 Radiotracer Techniques for Studying Pollutant Bioaccumulation in Marine Organisms.......54
S.W. Fowler, J.L. Teyssié, O. Cotret, J. Paganelli, B. Danis, M. Warnau

142 IAEA's Contributions to Advances in Nutritional and Environmental Metrology 56
G.V. Iyengar

146 Analytical Techniques in Radiation Technologies 58
A.G. Chmielewski

149 Sources of Environmental Radioactivity in Sediments of South of Gulf of Mexico..............59
P.F. Rodríguez-Espinosa, V.M.V. Vidal, F.V. Vidal

155 Intrinsic Quality Assurance Aspects of Neutron Activation Analysis....................................60
R.R. Greenberg

156 The Relevance of Speciation to the Environmental Behaviour of Radionuclides..................61
B.J. Howard

157 Mass Spectrometry for Nutritional and Environmental Applications: Recent Advances.......62
S.K. Aggarwal

158 Isotopic Techniques to diagnose Infection: with Special Reference to *Helicobacter pylori*..64
J. Boccio

159 Prevention and Care of Osteoporosis in the Elderly: Nutritional Perspectives and Isotopic Tools 65
W.T.K. Lee

160 Nutrient Fortification of Foods evaluated by Isotopic Techniques..66
M.G.V. Mannar

161 Nutrient-Pollutant Interactions and their Potential Implications on Human Health...............67
R. Gross, K. Gross, G.V. Iyengar

162 A Future for Nuclear Analytical Techniques? Why not?..69
P. Bode

163 Simultaneous Speciation Analysis using Neutron Activation 70
A. Chatt, C.S. Bottaro, C.K. Jayawickreme, J.W. Kiceniuk, Y. Shi

POSTER PRESENTATIONS

IAEA-CN-103/

003P Routine Monitoring of Nutrient Elements in Market Milk by INAA Technique 73
S.A. Jonah, I. M. Umar, I. S. Williams, E. M. Okonkwo, B.J. B. Nyarko, E.H.K. Akaho

005P Assessment of Natural Radionuclide Levels in Pakistan Foodstuffs and associated Radiation Doses 74
K. Khan, P. Akhter, S. D. Orfi, H. M. Khan

007P Radon-222 in Outdoor Air in the Finnish Arctic 75
J. Paatero, A. Virkkula, R. Hillamo, Y. Viisanen

010P Tracing of Mercury Sources in Nahuel Huapi National Park, Patagonia, Argentina, using Lichens as Atmospheric Bioindicators...76
S. Ribeiro Guevara, D. Bubach, M. Arribére

011P Heavy Metals Bioindication in Northern Patagonia Lakes, Argentina, using Native Mussel *Diplodon* sp...77
S. Ribeiro Guevara, D. Bubach, P. Vigliano, G. Lippolt, M. Arribére

014P Biomonitoring of Trace-Element Air Pollution in a Gold Mining Area in Ghana using the Generalized k_0-standardization NAA method 78
B.J.B. Nyarko, Y. Serfor-Armah, E.H.K. Akaho, A.W.K. Kyere

015P INAA Applications in the Age Dynamics Assessment of Ca, Cl, K, Mg, Mn, Na, P, and Sr Contents in the Cortical Bone of Human Iliac Crest 79
V. Zaichick

020P A Field Method for Assessing Body Composition by Portable XRF Bromine Analysis: Validation Against Instrumental Neutron Activation 80
J. J. Kehayias, I. E. Stamatelatos, C. Sheahan, M. O'Neill

021P High-Accuracy Method of Molybdenum Determination in Biological Materials by RNAA.81
B. Danko

022P Radioecological Situation in Montenegro......82
T. Andjelic, P. Vukotic, R. Zekic, R. Zizic

024P Rapid Determination of Artificial Alpha Nuclides with Long Lives using Time Interval Analysis Method 83
Y. Uezu, J. Koarashi, Y. Sanada, T. Hashimoto

029P Geochemical Environment and its Influence on Trace Element Content of Human Hair......85
V. Valković

030P Influence of Aerosol Concentration and Multivariate Data Processing on Indication of Radon Progeny Concentration in Air......86
B. Machaj, P. Urbanski

031P Multivariate Techniques in Processing Data from Radiometric Experiments......87
P. Urbanski, E. Kowalska

033P $^{239+240}$Pu and ^{90}Sr Deposition Densities in undisturbed Surface Soil in Vietnam......88
Nguyen Hao Quang, Nguyen Quang Long, Dinh Thi Bich Lieu, Tran Tuyet Mai, Nguyen Thi Thu Ha, Doan Tuan Anh, Dang Duc Nhan, Pham Duy Hien

036P Physico-Chemical Characterization of Radioactive Particles dispersed in Palomares (Spain) due to a Nuclear Accident 89
A. Espinosa, A. Aragón, B. De la Cruz, J. Gutierrez

038P Application of Nuclear and related Analytical Techniques in Biomonitoring......90
S. Dragović, S. Stanković, A. Čučulović

040P Determination of Sedimentation Rates and Sediment Yields using Cs-137 and Pb-210 Indicators 91
P.S. Hai, N.T. Binh, P.D. Hien, V.H. Tan

042P Measurement Of Boron in Soil using Proton Induced Gamma Emission Method......92
A.K.M. Fazlul Hoque, M.J. Abedin, S.K. Biswas

043P Evaluation of ^{99}Tc^{m}-UBI and ^{99}Tc^{m}-HYNIC-UBI as Potential Infection Imaging Radiopharmaceuticals......93
A. Korsak, R. Mikolajczak, B. Gorska, A. Markiewicz, E. Zakrzewska

044P Transfer of Iodine Deposited onto the Chinese Cabbage 94
H. Lee, H.J. Choi, H.S. Kang, D. Yu, K.M. Lim, Y.H. Choi, C.W. Lee

045P Determination of Chemical and Radionuclidc Impurities in ^{177}Lu used for Labelling of Radiopharmaceuticals......95
D. Pawlak, J.L. Parus, I. Sasinowska, R. Mikolajczak

047P Methods of Measurements of Activity and Radionuclide Purity in Radioisotope Centre POLATOM 96
K. Maletka, R. Broda, A. Tadrzak

049P Application of ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) in Analysis of Radioactive Preparations 97
I. Sasinowska, W. Piecyk

050P The new RIA Kit for the Determination of Progesterone in Cow's Milk 98
E. Byszewska - Szpocińska, A. Markiewicz

051P Neutron Activation Analysis at the Service of the Worker Health: Determination of Arsenic 99
M.Â. Menezes, E.C.P. Maia, C. Albinati

054P Gammaspectrometric Determination of Depleted Uranium in Soil 100
G. Pantelić, M. Eremić Savković, I. Tanasković, V. Vuletić, L. Javorina

061P Ra-226 and Ra-228 in bottled Mineral Waters in Germany 101
M. Beyermann, T. Bünger

064P The Sensitivity of Neutron Methods for On-Stream Analysis of Solutions 102
E.R. Kartashev

065P XRF Analysers and their Application in Ecology, in Mining and Processing Industries 103
S.M. Brodsky, V.P. Varvaritza, S.A. Koloskov, N.R. Kuzelev, Y.D. Lavrentjev, V.J. Nagorny, K.I. Shchekin

066P Preliminary Clinical Evaluation of ^{99}Tc^{m}-HYNIC-EDDA-TATE in comparison to ^{111}In-OCTREOSCAN and ^{131}MIBG 104
R. Mikolajczak, B. Gorska, A. Hubalewska, K. Fross, A. Staszczak, B. Huszno

073P Use of Geostatistical Analysis in Radon Mapping 105
F. Ďurec, T. Hlásny, R. Prokešová

077P Quality Control of INAA-k$_0$ and ICP-MS as Bio-Monitoring Analysis Techniques - Application to Moroccan Atmospheric Pollution Study 106
T. El khoukhi, R. Cherkaoui, A. Senhou, A. Couak, A. Gaudry, S. Ayrault, M. Chakir

078P An XRF Study on the Pigments in Wood Carving of Jesuit Missions of Argentina 107
A. Germanier, R.D. Pérez, R. Badini, M. Ravera, M. Rubio, J. Piana, A.M. Peiretti, A. Ávila

080P An Application of the X ray Fluorescence and Multivariate Analysis for the Study of the 18th Century Vessels from Lubaczow Glasshouse 108
J. Kierzek, J. Kunicki-Goldfinger, A.J. Kasprzak

084P Precise Uranium Isotopic Measurements in Groundwater around the CEA's Vaujours Site 109
S. Baude, Fa. Bointurier, J.C. Millies-Lacroix, R. Chiappini

090P Distribution of Gamma Emitter Radionuclides in Coastal Sediments near the Venezuelan Atlantic Front 110
J. Alfonso, D. Palacios, L. Sajo-Bohus, J. Castillo, J. Bermúdez

093P Gamma Radioactivity in Sediments of Maracaibo Lake, Venezuela 111
T. Viloria, L. Sajo-Bohus, D. Palacios, J. Castillo, J. Bermúdez

100P Determination of Atmospheric Concentration of Toxic Metals along Urban Motorways in two Nigerian Cities using TXRF Technique 112
H.B. Olaniyi, I.B. Obioh, F.S. Oliseh, O.K. Owoade

102P Sequential Leaching Extraction of ^{239,240}Pu, ^{238}Pu, ^{241}Pu and ^{241}Am from a Mud Sample: An Intercomparison Study 113
C. Gascó, A. Komosa, A. Álvarez, N.Navarro, M.P. Antón

104P Prompt Gamma Neutron Activation Analysis of Boron in Samples by using an Am--Be Isotopic Neutron Source 114
H. Yücel, M. Atıf Çetíner, Ş. Turhan, A. Demírbas

107P Measurement of Nitrogen in Explosives using Nuclear Techniques 115
A. Ahmadiniar, J. Rahighi, A. Emamjomeh

110P An Overview of Indoor Radon Study carried out in Dwellings of India and Bangladesh
During the Last Decade (1990-2000)..116
A. Srivastava

112P Radionuclide Analysis by Gamma-Ray Spectrograms of Environmental Samples 117
S.K. Aliyeva

117P Newer Trace Elements Measured by RNAA and AAS 118
A.G. Gharib

118P Se and I Content in Military Total Diet 119
V. Stibilj, L. Pograjc, C. Hlastan Ribič, D. Pokorn, P. Smrkolj, A. Čibej, Z. Trkov

121P Behaviour of Radioactive Cesium in Northern Boreal Forest Ecosystems 120
J. Lehto, T. Jaakkola, I. Outola, M. Tillander, R. Pehrman

122P Carbon Sequestration and estimated Carbon Credit Values as measured using
^{13}C Labeling and Analysis by an Optical Breath Test Analyser...121
R.C. Hood, M. Khan, A. Haque, M. Khadir, J.P. Bonetto, L. Mayr, M. Heiling

130P The Tranfer of Radiocesium from Fallout and Artificially Contaminated Soil to Tea
and Black Cabbage Leaves 122
S. Topcuoğlu, Ç. Kırbaşoğlu, A. Köse

133P Leaching of Radioactive Isotopes from Ash...123
G.A. Aycik, M. Paul, A.Sandstrom, J.Paul

135P Risk assessment of Radon Exposures in Zonguldak Bituminous Coal Basin in Turkey......124
N. Çelebi, A. Fişne, G. Ökten

137P Biomonitoring Air Pollution in Chile 125
E. Cortés, N. Gras, I. Pereira, O. Andonie, L. Muñoz, X. Rojas, R. Riquelme, M. Molina

138P Deposits Monitoring and Health Consequences in Tien-Shan 126
I. Hadjamberdiev

141P Monitoring and Evaluating Efficacy and Effectivenss of Fortified Food based
Interventions using Isotopic and Nuclear Techniques 127
B. Miranda-da-Cruz, N. Mokhtar, V. Iyengar

143P Determination of Trace Elements in Mineral Water Samples using
Total Reflection X ray Fluorescence (TXRF)...128
M.J. Mangala, K.A. Korier, D.M. Maina, A.M. Kinya

147P Determination of Iodine Species in Cow Milk by Preconcentration Epithermal
Neutron Activation Analysis...128
K. Isaac-Olive, A. Chatt

153P Natural Radioactivity Measurement in Spring Waters by the Use of SARAD U/Ra-Disc
Method 130
B. Kozlowska, T. Streil, D. Dawczynski

165P Energy Requirements and Physical Activity Level of Active Elderly People in
Rural Areas of Cuba..131
M.H. Triana, H.A. Mateo, M.V. Julleirat, G. Salazar , S. González, V. Sánchez, B. Basabe,
M.E. Díaz, E. Toledo, A. Cabrera

166P New Technology of Diagnostic and Control of a Thyroid Disease Treatment using
in vivo X Ray Fluorescent Analysis 132
V.V.Berezkin, V.Z.Zavelev, S.A.Koloskov, N.R.Kuzelev, V.U.Rodionov, A.S.Shtan,
K.I. Shchekin, L.D.Soshin, I.0.Tomashevsky

167P Estimation of Progesterone in Bovine Milk by Liquid Phase Radioimmunoassay for Veterinary Applications 133
T. Karir, P. Chaudhury, A. Samad, U.H.Nagvekar, N. Sivaprasad

168P Variation of Methylmercury Concentration in Hair of the Kuala Lumpur Residents in terms of Race, Gender, Age and Fish Consumption 134
S.B. Sarmani, I. Alakili

169P Stable Isotope Composition of Food from different regions of Poland 135
R. Wierzchnicki, M. Derda, A. Mikołajczuk

170P Fast method for measuring the ^{90}Sr Activity with Cherenkov Radiation in Silica Aerogel..136
R. Pestotnik, P. Križan, S. Korpar, A. Stanovnik

172P Comparison of Liquid-Liquid Extraction and Solid Phase Extraction for Manganese in Water analysed by Neutron Activation Analysis 137
S.B. Sarmani, A.M. Bobaker

173P Irradiation Counting System for Analysing Large Samples by Short-Time Activation Analysis 138
S.S. Ismail

174P Radiotracers and CFD Methods for Wastewater Treatment Apparatus Investigation 139
J. Palige, A. Dobrowolski, A. Owczarczyk, A.G. Chmielewski

183P Soil to Plant Transfer Factor for Radiocesium by Field Measurement 140
A. Jalil, M.M. Rahman, Md. Mazibur Rahman, A. Koddus

186P Determination of Elemental Composition and Probable Sources of Atmospheric Aerosol in Tirana by EDXRF Analysis 141
N. Civici

187P Importance of the Speciation of Radionuclides for the Calculation of Transfer Coefficients: Application to Soil-Fungus Transfer 142
A. Baeza, J. Guillén, S. Hernández

189P Organically bound Tritium, OBT: its true Constitution 143
F. Baumgaertner, W. Donhaerl

197P Investigations on the Bioavailability of ^{137}Cs and $^{239+240}$Pu in Aerosol and Dust Samples by Fractional Extraction 144
U.Ch. Gerstmann, G. Rosner, K. Bunzl

ORAL PRESENTATIONS

Study of Organohalogens in Foodstuffs and Environmental Samples by Neutron Activation Analysis and Related Techniques

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Organic halogens, especially organochlorinated compounds, which come from extensive use of pesticides and herbicides, and discharge of wastewater from bleaching of pulp and wastewater treatment, have caused world-wide contamination and drawn great concern. Polychlorinated biphenyls, hexachlorobenzene, organochlorinated pesticides and their metaborites are well-known pollutants in the environment because of their persistence, bioaccumulation and potential environmental hazardous effect. Recently, a significant number of studies indicated that traditional analytical methods such as gas chromatography and gas chromatography- mass spectrometry could only provide information about the known organochlorines, which contributed to less than 1-20 % of total amount of extractable organochlorinated compounds in samples and therefore the results couldn't reflect their actual contamination levels. Instrumental neutron activation analysis is the only analytical method currently available for simultaneously determining various extractable organohalogens.

In this work an INAA method combined with organic solvent extraction for determination of extractable organohalogens (EOX) in milk and pine needle collected from various regions of China has been established. The detection limits are 50 ng, 8 ng and 3.5 ng for Cl, Br and I, respectively. The concentrations of EOX in the samples are decreasing in the order of EOCl >> EOBr > EOI. The average concentration of EOCl in milk is 4.44 μg/g expressed as fat weight basis, with the highest 17.6 μg/g on fat weight basis from the developed regions in China. The mean concentrations of total HCH and DDT are 0.038 μg/g and 0.046 μg/g, respectively. Organochlorine pesticides only account for 1.6% of the EOCl, indicating the very high proportion of the unknown EOCl in the milk samples.

The concentrations of EOCl, EOBr and EOI in pine needles are 0.5-6.0, 0.06-0.54 and 0.013-0.4 μg/g dry weight, respectively. 5 to 38 % of EOCl exist as extractable persistent organochlorines (EPOCl) after treatment with concentrated sulfuric acid. It is observed that the average concentrations of EPOCl noticeably increase from south to north China. The relative proportion of the known organochlorinated pesticides to total EPOCl is 3.0-19.8 %, which also indicates that a major portion of EPOCl in pine needles is unknown. Further, a positive correlation of the organohalogen levels in milk and pine needle with the local social-economic index was also found.

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Radioactive Monitoring at Jakarta Bay and Muria Coastal Zone in Indonesia

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Primary objectives of radioactive monitoring at coastal environmental in Indonesia are covering three aspects. First aspect is assessment of adequacy of controls on the release of radioactive material. Second aspect is assessment of actual potential exposures of man to radiation or to radioactive materials present in environmental matrices in normal situation. Third aspect is assessment of magnitudeand extent of possible radiation hazards to public in the even of an emergency for the purpose taking appropriate counter measures.

The radioactive monitoring has been implementing at Jakarta Coastal and Muria Peninculla. The goal of monitoring activities at Jakarta bay is ultimately to provide some informations of impact operational nuclear facilities and application nuclear techniques in industries. In other hand at Muria Peninculla are to provide the base line data before operational of fosil fuel power plant. The monitoring was covering for six stations at coastal and offshore zone. Three kind of samples was taking from each station are sediment, water and local biotas. Dose rate and Gross alpha/betta analysis were taken to find early information abaout radioactivity conditions. Gamma analysis were taken to to find radioactive contamination.

The result of monitoring are shown that condition of coastal and offshore zone at Jakarta bay and Muria peninculla was lower than Indonesia regulation standard.

Heavy Metals Inputs in Northern Patagonia Lakes from Short Sediment Cores Analysis*

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Short sediment cores were sampled from lakes located in Nahuel Huapi National Park, Northern Patagonia, Argentina, in order to determine heavy metal inputs to these water bodies from the analysis of elemental concentration profiles. Elemental contents were determined by Instrumental Neutron Activation Analysis, with special attention on mercury determinations, and measuring also potential pollutants Sb, Ag, As, Cr, Ti, V. In order to identify different processes that may happen within the sediments the concentration profiles of major and minor elements Fe and Mn, associated with diffusive diagenetic processes, Al, Ca, and Na, geochemical tracers (Rare Earth elements, Sc, Hf, Ta, Th, and U), trace elements Ba, Br, Co, Cs, Sr, Rb, and Zn, and organic matter contents by LOI, were determined. Core dating was performed by measuring natural ^{210}Pb and anthropogenic ^{137}Cs, and by tephra identification. Total ^{210}Pb, ^{226}Ra, associated with supported ^{210}Pb, and ^{137}Cs specific activity profiles were measured by low background gamma-ray spectrometry. Sedimentation processes were found to be affected by volcano ashes deposition, and by diffusive diagenetic processes with heavy metal mobilization after sediment deposition. No evidence of input increase to lake environments of trace elements Sb, Ba, Cs, Zn, Co, Hf, Ni, Se, Sr, Ti, U, and V was observed. High As concentrations (up to 250 $\mu g.g^{-1}$) were found associated with Mn and Fe oxides diffusion processes. Strong association between Br concentrations and organic matter contents was observed in sediment cores, but no evidence of relevant increase of Br inputs to the aquatic systems studied was observed in recent years. Ag concentrations were found to be enriched in upper core layers over base line values determined from deep layers measurements, which range from 0.1 to 0.2 $\mu g.g^{-1}$. Hg concentration profiles of sediment cores sampled from lakes, or lake branches, with higher productivity (organic matter contents of upper most layer ranging from 17 to 24 %) showed a peak at 1 to 2 cm below lake bottom, with concentration values ranging from 0.6 to 2.8 $\mu g.g^{-1}$. The water body with lower productivity (6 % organic matter contents) does not show this peak in the concentration profiles, and Hg contents range from 0.2 to 0.3 $\mu g.g^{-1}$ in upper core layers. Two background levels were determined from deep layers measurements; the lower associated with pre-industrial time according to core dating, ranging from less than 0.07 to 0.2 $\mu g.g^{-1}$, and the other associated with modern times, ranging from 0.1 to 0.3 $\mu g.g^{-1}$.

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[*] This work was performed within IAEA Technical Co-operation Project ARG/7/006 “Investigation of mercury and other heavy metals in water bodies of Nahuel Huapi National Park, Argentine Patagonic Andean Range. Base lines determinations, trophic web pathways investigation and contamination source identification”.

Use of D-T Produced Fast Neutrons for *in vivo* Body Composition Analysis: a Reference Method for Nutritional Assessment in the Elderly

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Body composition has become the main outcome of many nutritional intervention studies including osteoporosis, malnutrition, obesity, AIDS and aging. Traditional indirect body composition methods developed with healthy young adults do not apply to the elderly or diseased.

Fast neutron activation (for N and P) and neutron inelastic scattering (for C and O) are used to assess *in vivo* elements characteristic of specific body compartments. Non-bone phosphorus for muscle is measured by the $^{31}P(n,\alpha)^{28}Al$ reaction, and nitrogen for protein via the (n,2n) fast neutron reaction. Inelastic neutron scattering is used to measure total body carbon and oxygen. Body fat is derived from carbon after correcting for contributions from protein, bone and glycogen. Carbon-to-oxygen (C/O) ratio is used to measure distribution of fat and lean tissue in the body and monitor small changes of lean mass.

A sealed, D-T neutron generator is used for the production of fast neutrons: 10^8 n/s/4π at 10KHz repetition rate. Carbon and oxygen mass and their ratio are measured *in vivo* by neutron inelastic scattering, at a radiation exposure of less than 0.06 mSv. Gamma ray spectra are collected using large BGO detectors and analysed for the 4.43 MeV state of carbon and 6.13 MeV state of oxygen, simultaneously with the irradiation. P and N analysis by delayed fast neutron activation is performed by transferring the patient to a shielded room equipped with an array of NaI(Tl) detectors.

A combination of measurements makes possible the assessment of the “quality” of fat free mass. The neutron generator system is used to evaluate the efficacy of new treatments, to study mechanisms of lean tissue depletion with aging and to investigate methods for preserving function and quality of life in the elderly. It is also used as a reference method for the validation of portable instruments of nutritional assessment.

Simultaneous Determination of Radionuclides Separable into Natural Decay Series using Time Interval Analysis (TIA)

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1. A delayed coincidence method, called a time interval analysis (TIA) method, has been successfully applied to selective determination of the correlated α-α decay events in millisecond order life-time. The decay processes are including $^{220}Rn \rightarrow ^{216}Po(T_{1/2}$:145ms)$\rightarrow$ {Th-series}, and $^{219}Rn \rightarrow ^{215}Po(T_{1/2}$:1.78ms)$\rightarrow$ { Ac-series}. The TIA is fundamentally based on the analysis of time intervals due to pulse from the decay events in the liquid scintillation counting (LSC). In the LSC, non-correlated decay events and other events became background or random events when they were compiled the time interval data within a fixed time (for example, a tenths of concerned half lives). Time intervals of the correlated or successive decay events could be distinguished because the exponential part of the correlated events is superimposed on those of a variety of random events as a horizontal line. This is so-called the multiple time interval analysis (MTA).

The detection efficiency of the TIA-analysis due to correlated α decay events could be subsequently improved in respect of background elimination using the pulse shape discrimination technique (PSD with PERALS counter) to reject α-pulses and applying solvent extraction of Ra.[1)]

2. In the present paper, the determination of another α-emitter nuclide, ^{225}Ra, which belong to Np-decay series, could be also carried out using the TIA-method using the growth relation of the correlated α–decay events due to $^{221}Fr \rightarrow ^{217}At(T_{1/2}$:32.3ms) process when ^{225}Ra was employed as a chemical yield tracer. TIA-measurement of ^{225}Ra was required after almost maximal growth of progenies about 20 days later because of keeping transient equilibrium between ^{225}Ra and ^{225}Ac. During such waiting period, the growth of ^{222}Rn, ^{218}Po, ^{214}Pb from ^{226}Ra-progenies always disturbs the α-spectrum in the LSC and brings on the increment of random events. To improve this situation, the purging effects of ^{222}Rn with N_2-gas were effectively accomplished just before the TIA-measurement.

As a result, the simultaneous determination of Th and Np-series (chemical yield tracer; ^{225}Ra) was achieved by applying the TIA methods, while ^{226}Ra (uranium decay series) was determined from the α-LSC spectrum. This method is proved to be useful for the environmental samples.

Furthermore, this TIA-method has been tested for the determination of descendants of Rn-gas which was collected on a dust filter in the environment.

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The Internal Comparator Method in INAA

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For a small sample measured at the closest position to a Ge detector, the peak efficiency is 30–40 times as high as that at the 15 cm position. However, INAA results from this or similar counting positions are often accompanied with poorer accuracy, because peak efficiency at the low counting position is much more sensitive to counting geometry. As a common practice in INAA, whenever possible, far counting distances are used, particularly for works designing good accuracy. The price paid for it is high: poor detection limits or less detectable elements, long counting time or poor counting statistics, and long turnout time or low throughput.

The internal comparator method is a solution, which promises reliable INAA results also from the closest counting position for samples with even “bad” geometry. When the content of the internal comparator in sample is determined independently, this method can be used in INAA of materials suffering from thermal neutron self-shielding. In this work, feasibility and performance of this method was demonstrated by an analysis of SRM1575a (pine needles), an unknown sample from ASTM Task Group inter-laboratory comparison sponsored by NIST. 28 elements were successfully determined and reported in a short period. Application of this method in analyses of glasses having much B and Cd is presented. To apply the internal comparator method, the k_0-method must be available.

Elemental Contents in Napoleon's Hairs cut before and after his Death: did Napoleon die from Arsenic Poisoning?

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The debate on the cause of Napoleon's death became an interesting subject four decades ago when high concentration of arsenic was found in his hair and the arsenic poisoning was suggested to be responsible accordingly. This work reports INAA results for 19 elements (Ag, As, Au, Br, Ca, Ce, Co, Cr, Fe, Hf, Hg, K, La, Sb, Sc, Se, Sm, W, and Zn) in Napoleon's hairs collected at different times and places: two pieces cut the day after his death on Island St. Helena (6 May, 1821) and two pieces cut seven years earlier during his first exile on Island Elba (1814). Elevated As contents were found in all the hairs. Apparently, the finding of high As contents in his hairs collected seven years before his death is not favourable for the As poisoning theory, because the murder was assumed to have been carried out on the Island St. Helena. High content of Sb was found only in his hairs cut on St. Helena, which is apparently a coincidence to a documented event that he was frequently given tatar emetic in two months before his death. Mercury content in all determined hairs was found in the normal range. High concentrations were found also for elements Ag and Au in his hairs. For direct comparison, elemental contents in four hairs collected just before analysis from a man and a woman living in Berlin were presented.

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Utilization of Stable Isotope, ^{26}Mg, for Investigating the Cause of Sudden Death

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In our investigation of sudden death problem in north-east Thailand, where high prevalence of sudden death appeared among young males in 1980s and 1990s, we found that magnesium deficiency was an important factor in addition to potassium deficiency.

Stable isotope of magnesium, ^{26}Mg, was used as a tracer in order to observe the behavior of xenobiotic magnesium, and we knew that maintaining magnesium level in heart was very important to protect body from sudden death.

We started animal experiments and obtained the reproducible results. Even in magnesium deficient condition, heart muscle and kidney maintained the normal levels of magnesium, although the magnesium levels extremely reduced in blood, liver, and other organs. It means that magnesium is mobilized to heart and kidney from other organs for survival. Mice were intravenously injected with ^{26}Mg after feeding magnesium deficient diet. The behavior of ^{26}Mg in heart was different from that in the other organs, that is, incorporation of ^{26}Mg into heart delayed in comparison with the other organs. We are now investigating the magnesium status in whole body to know what type of magnesium status is feasible to induce sudden death.

Concentrations of magnesium and other various elements in food, water and other environmental materials collected in north-east Thailand were analysed by microwave induced plasma mass spectrometry and magnesium intake of residents in this area was estimated.

Use Tracer Technique to Investigate the Dependence of Soil-to-Plant Transfer Factor of Sr and Cs on the Type of Soils

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Investigation of soil-to-plant transfer factor (TF) of ^{137}Cs and ^{90}Sr shows that this quantity varies within a wide range from 0.0002 to 10 and it seems to depend upon the soil type. This makes the uncertainty of dose assessment to be very large. So study on soil-to-plant TF is essential. To improve the specificity of radiological assessment models and to have more precise information about the environmental parameters to be used to set limits for authorized discharges from nuclear installation and to plan a better emergency response, particularly in developing countries, through the replacement of generic data with those more relevant to local conditions.

In this work ^{85}Sr and ^{134}Cs were used as tracers for Sr and Cs. Use of the two gamma emitting isotopes allows to simplify analytical procedures, particular in case of having trace amount. Three types of soil chosen for this study are Eutric Fluvisols, Ferralic Acrisols, Orthi-thionic Fluvisols. Two types of crop for reference are cabbage and rice. The cabbage and rice are planted in pots. The parameters, which were thought to affect the soil-to-plant TF, are pH, exchangeable K, exchangeable Ca, Cation Exchangeable Capacity (CEC), organic matter (OM), concentration of radionuclide in soil, also to be determined along with the transfer factor.

From the observation of Cs soil-to-plant TF values and Sr soil-to-plant TF values, the analysis of dependence of TF value on the type of soil, crop, radionuclide was done by using stepwise multiple regression method of SPSS software. The results obtained indicated that the parameters (constant, CEC and concentration of radionuclides in soil) can explain more than 70% of variance of TF value.

This work was carried out in the frame work of an IAEA CRP entitled "The classification of soil systems on the basis of transfer factors of radionuclides from soil to reference plants" for the period from 1999 to 2002.

Nutrient-Pollutant Interactions and their Potential Implications on Human Health

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Little information exists on the relationship between environmental pollution and the nutritional status of humans. The purpose of this report is to provide an overview of factors influencing nutrient-pollutant interactions within the human body. The absorption of essential and toxic elements depends on the speciation and bioavailability of substances, as well as the physiological status of humans, such as their age. The pre-existing trace-element status of people also influences the absorption of elements. Some interactions between elements occur predominantly in specific organs. Furthermore, the interactions will be affected by the environment of people. The geographical location, for example governs food availability and type, and high altitudes can alter the requirements for some nutrients. Socio-cultural aspects, such as the processing and preparation of food can affect the levels and bioavailability of compounds. Thus, many factors influence the interactions between pollution, the nutritional status of people and human health. This extremely complex system needs to be understood in more detail to reduce ill-effects on human health and economic costs.

Metrological Assessment of the High-Accuracy RNAA Method of Co Determination in Biological Materials

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In the contemporary world, chemical measurements are the basis for making central decisions to effective functioning of the society. The areas critically dependent on results of chemical analysis are e.g. environmental control, health, food safety, crime detection, support for R&D. Hence, there is a need for checking the reliability of the results of chemical analysis. This is of great importance esspecially in the case of trace analysis. One of the ways of checking the accuracy of chemical results is the use of primary methods. The aim of the presented paper has been to show that radiochemical neutron activation (RNAA) method can meet criteria for a primary ratio method (a definitive method) [1].

The high-accuracy RNAA method for the determination of trace amount of cobalt in biological materials has been developed. The method is based on a combination of neutron activation with selective and quantitative isolation of the analyte in a state of high radiochemical purity by use of column chromatography followed by gamma-ray spectrometric measurements. The method was devised according to a set of rules, which were formulated to obtain high accuracy of the method. The procedure has been also equipped with several criteria, being a key factor of quality assurance. The criteria have to be fulfilled by a result of analysis in order to be accepted.

The paper summarizes the work on the development of the method and demonstrates the qualifications of the eleborated method as a primary ratio or a definitive method. The usefulness of the elaborated method in the certification of the candidate reference materials: Tea Leaves and Mixed Polish Herbs is presented.

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Application of Nuclear Microprobe Techniques in the Analysis of Biological Materials

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A nuclear microprobe facility has been installed at the –15 degree port of the 3 MV Tandetron (HVEE), at the National Centre for Compositional Characterisation of Materials, BARC, Hyderabad. The beam line comprises high precision object and collimator silts, a quadrupole triplet lens assembly and a beam scanner from Oxford Microbeams. The end station comprises an indigenously fabricated octagonal scattering chamber and a sample manipulator. The scattering chamber has provision for housing several detectors and is also equipped with a zoom microscope for viewing the beam spot directly on a quartz plate. Examination of a specimen by different ion beam techniques such as Proton induced X ray emission (PIXE), Proton induced gamma ray emission (PIGE) and backscattering spectrometry (BS) can be performed simultaneously over a scanned area with a spatial resolution of about 5 microns at present.

This paper describes the application the nuclear microprobe and other conventional ion beam analysis techniques in the analysis of samples of environmental importance and health related specimens. It involves examination of biological matrices such as IAEA 413 (single cell algae) and a plant sample, being developed as an in-house reference material, by μ-PIXE to assess their homogeneity. Elemental mapping suggest significant inhomogeneous distribution of Fe and Mn. This is in contrast to results obtained using conventional PIXE and other instrumental analytical techniques. The spatial distribution of Ca and P in lateral and longitudinal sections of teeth specimens obtained by μ-PIXE measurements has also been studied. In addition, PIGE results on samples used as biomonitors for trace element pollution are presented.

Glucose Tolerance by $^{13}CO_2$ Breath Test Methodology and Utilization

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The glucose tolerance test is a valuable diagnostic aid. The ability to utilize carbohydrate is decreased in diabetics and increased in hypopituitarism, hyperinsulinism, and adrenocortical hypofunction. Developments in mass spectrometric technology and availability of ^{13}C-enriched substrates for clinical research have enabled the clinician to perform $^{13}CO_2$ breath tests in normal and patients with various diseases. In this paper, we planned to evaluate the applicability of the non-invasive $^{13}CO_2$ breath test for glucose tolerance studies and for the diagnosis of disorders of carbohydrate metabolism in adults using natural glucose. The methodology for breath sample collection, storage and analysis was developed and experimental conditions were designed and optimized. Static absorption of breath CO_2 was carried out by having the subject exhale through a Tygon tube attached with glass adapter into an empty 250 ml flat bottom flask. Flask was closed by stopper after adding 10 ml 1.5 N NaOH solution and was shaken for 5 minutes. Samples were stored in plastic lined screw-cap vials for analysis.

Analysis of same breath sample ($\delta\ ^{13}C$ value –25.63, n=3) and laboratory internal standard ($\delta\ ^{13}C$ value –3.56, n=4) show precision 0.10 and 0.03 respectively. Glucose tolerance test was performed on normal volunteers using naturally labeled glucose (glaxose-D) in fasting and non fasting conditions using standard test meal. MS Excel software template for trioctanoic acid breath test, got from W. A. Coward, Dunn Nutrition Center, U. K. was modified for calculations of cumulative percentage dose of ^{13}C recovered from natural glucose. Mean glucose tolerance test data from Marcel Lacroix (1973) was used to the modified template and cumulative percentage of ^{13}C dose was calculated and compared with our experiments' results. Marcel Lacroix fasted data shows percentage dose recovered 30.53 ± 4.06, n=8, 20-32 years. PINSTECH fasted data shows percentage dose recovered 31.28 ± 1.68, n=3, 23-40 years and non fasted data shows percentage dose recovered 21.31 ± 0.97, n=2, 24-27 years. It was observed that our fasting experiment results are in the normal range.

Key words: Glucose tolerance test, ^{13}C, Isotope ratio mass spectrometer.

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The TDCR Method as an Important Tool in Radionuclide Metrology

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The paper presents Triple-to-Double Coincidence Ratio (TDCR) method as an important tool in radionuclide metrology for standardizing pure β- and pure EC-radionuclides. Many metrological laboratories in the world are using this method. The TDCR method was adapted to the international reference system (SIR) in the Bureau des Poids et Mesures (BIPM) in Sévres and establish a part of the National Standard of Radionuclides Activity Unit in Poland. The principles of the TDCR method and the measurement device based on the Liquid Scintillation Counting (LSC) are described. An example of standardization results and a list of radionuclides measured by the TDCR method are given. Application of the method for standardizing radiopharmaceuticals and preparation of standards for detectors calibration for environmental and nuclear medicine purposes is pointed out.

Monitoring of Ground Level Air in the Framework of Trace Analysis: Methods and Results

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Trace analysis allows the sensitive detection of radionuclide concentrations in ground level air in the range of µBq/m³. Typical time scales of less than one day up to a few days can be obtained in routine operation.

Trace analysis measurements are performed in the framework of the German Integrated Measuring and Information system (IMIS) as well as within the International Monitoring System (IMS) used for the verification of the Comprehensive Nuclear Test Ban Treaty (CTBT). Within the environmental monitoring programmes of IMIS the Federal Office for Radiation Protection (BfS) performs measurements of aerosol bound radionuclides as well as of radioactive noble gases in the atmosphere. Aerosols are collected on filters with high volume air samplers and analysed by γ-spectrometry, α-spectrometry and integral measurements of the β-activity with preceeding radiochemical separation. Noble gas samples from 15 sites worldwide are analysed to observe the ^{85}Kr-release from nuclear fuel reprocessing plants and from 7 sites in Germany to monitor the ^{133}Xe emitted from nuclear power plants.

As part of the IMS an automatic aerosol sampling and measuring system as well as an automatic noble gas sampling and measuring system will be operated by the BfS at mount Schauinsland near Freiburg. Due to the expertise in noble gas measurements the BfS had been choosen to perfom intercomparison experiments in advance with several automatic noble gas sampling and measuring systems to be used within the IMS.

The general principles of the methods used for trace analysis and results from the BfS will be presented and discussed.

In order to establish quality assurance programmes for trace analysis performed for IMIS a close collaboration between the involved German institutions has been established. First steps for the expansion of the cooperation to other European laboratories have been made. An informal data exchange between trace analysis laboratories in Europe (Ring of Five) already exists and allows in case of enhanced activity concentrations a fast overview of the radiological situation and helps to identify possibles sources. Results from this cooperations will be presented and the importance of such international networks be emphasized.

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INAA Applications in the Assessment of Minor and Trace Element Contents in the Soil of Moscow's Park

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Within recent ten years Moscow traffic increased greatly that made the ecological situation of the Russian capital much worse. The topsoil is a strong absorber of many chemical elements keeping them in the surface, the most fertile layer. So, samples of the soil surface layer can be advisably used as a bioindicator of the environmental state.

Instrumental neutron activation analysis (INAA) was used to determine contents of chemical elements in topsoil (A-horizon) of one of the Moscow's park. It was shown that INAA allowed determining mass fraction of 26 chemical elements such as As, Ba, Br, Ca, Ce, Co, Cr, Cs, Eu, Fe, Gd, Hf, La, Lu, Nd, Rb, Sb, Sc, Sm, Sr, Ta, Tb, Th, U, Yb, and Zn in the soil samples even at the natural (uncontaminated) levels. The method allowed estimate levels of Ag, Au, Cd, Hg, and Se in soils too if concentrations of these elements are higher detection limits, 1.0, 0.02, 2.0, 0.1, and 0.5 µg/g, respectively. The mass fraction of 30 chemical elements out of 31 in the investigated topsoil were in good agreement with ranges of chemical element contents in the uncontaminated turf-podzol and loam soils of Europe and Central European part of the Russia. The total contents of all measured chemical elements are within the range characteristic for "norm" or "clean" soil and do not exceed environmental quality standards for soils of Russia.

Regulatory and Scientific Aspects of Environmental Studies

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Radiation Protection Centre is regulatory authority in Lithuania responsible for control of radiation protection of both public and radiation workers. Radiation Protection Centre coordinates the actions of governmental, municipal executive and other institutions in the area of radiation protection, conducts assessment of population exposure and expertise. Among other tasks the measurements of natural and artificial radioactivity are performed constantly. The laws and governmental decisions in the field of radiation protection in Lithuania were prepared on the basis of the International Basic Safety Standards, Council Directive 96/29/EURATOM, European Drinking Water Directive and according other directives and international standards. Monitoring of natural and artificial radioactivity is carried out in the samples of drinking water, food, soil, fallout, construction materials, biological and other. The ambient gamma dose rate measurements are performed in the vicinity of Ignalina NPP and in other regions. The measurements of indoor radon concentrations in detached houses are carried out constantly from 1995. After investigations were carried out the national maximum permitted levels for indoor radon and radon in water were set. From the beginning of the next year the radiological monitoring is decided to be performed according to the Commission Recommendation of 8 June 2000 on the Application of Article 36 of the Euratom Treaty Concerning the Monitoring of the Levels of Radioactivity in the Environment for the Purpose of Assessing the Exposure of the Population as a Whole. The regulation was approved on this. The regulation include a list of institutions are responsible to carry out radiological monitoring, the order of sampling and measurements, reporting of results. Doses on the basis results of measurements are calculated.

Multiple Techniques used for Radiological Characterization of the Magurele Fortress – Battery 14-15, Romania

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Temporary storage of radioactive wastes on the site Magurele Fortress – Battery 14-15, near Bucharest, Romania, led to its radioactive contamination. External zone of the Battery 14-15 building was used as temporary deposit for radioactive materials as well as an working area for segregation and packaging during the partially decommissioning of this intermediary radwaste deposit. This decommissioning was not followed by a ecological restoration, the zone remaining contaminated.

In the frame of the contract no. 815/70/2001 developed under financial assistance of Romanian Government (Bucharest – Ilfov Regional Development Agency, Local Initiative) was performed the radiological characterization using the following techniques:
- *in depth* contamination measured in lab on the soil samples
- lab measurement of radioactivity migration from soil in plants, on the vegetation samples
- γ measurements *in situ* using high resolution spectrometry determination of isotopic composition as well as contaminant radionuclide concentration
- measurements for scanning of small areas with elevated radioactivity in order to determine radwaste volume in future site restoration
- β-γ dose measuring in contaminated areas.

Using of multiple techniques combining the measurements *in situ* and analytical laboratory determinations permitted the obtaining of consistent results reffering to contaminant radionuclide concentration in soil.

The following issues have been determined by radiological characterization performed on the external area (actually on the public domein) of the former radwaste storage Magurele:
- depth of contamination in soil as well as the concentration of contaminants
- surfaces of the small areas having elevated level radioactivity used for calculation of radwastes volume which must be removed (materials having the radioactivity over the free release limits established by in force legislation of the country)
- factors of soil-plant transfer
- exposure dose rates for the workers involved in the restoration activities.

Application of the statistical tests regarding the contamination level of the surveyed area show that this site can not be free released, being necessary works for ecological restoration of this place in public domain.

Provenance Study of Amerindian Ceramic Figurines with PGNAA

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Prompt gamma activation analysis facility has been developed at the Budapest Neutron Centre since 1996. Its applicability to archeological research has already been established, supported by several studies. In collaboration with the Universidad Simon Bolivar, Venezuela it was decided to use PGNAA to determine the provenance of some prehistoric pottery figurines.

From five archaeological sites excavated in the Archipelago Los Roques, almost five hundred pre-Hispanic potteries were recovered. Amerindian groups from adjacent Venezuela mainland were identified as the campsite occupants between 1200 A.D. and the European contact period. Three samples from Valencia Lake Basin and five from Los Roques were selected for preliminary research purposes.

Microscopic properties of pottery such as chemical composition can give information on its origin, place of manufacture, the raw material origin, the production method and trade among others. PGAA as the most convenient non-destructive method was chosen to measure major and trace elements. Furthermore, we show that these results will contribute in assessing the origin of pottery.

The samples were irradiated with a cold (20K) neutron beam of $5 \cdot 10^7$ cm^{-2} s^{-1} and the prompt-gamma ray spectra were collected with a HPGe-BGO detector system. The element identification and concentration calculations were performed based on our data library. We were able to determine the major components of H_2O, Na_2O, MgO, Al_2O_3, SiO_2, K_2O, CaO, TiO_2, MnO, Fe_2O_3 parallel with trace elements of B, S, Cl, Sc, V, Cr, Ba, Sm, Eu, Gd. According to our measurements the concentration of K_2O, Cl and Cr are significantly different in the samples from Valencia Lake Basin (mainland) and in those of Los Roques Islands.

After the first encouraging result a second branch of archaeological objects were investigated, from both the mainland and the islands region. In order to make the provenance study more convincing, a set of soil samples from the environment of the archaeological localities were collected and investigated with PGNAA, too.

The Current Status and Further Development of the Nuclear and Isotope Analytics in an Industry (Ecological Aspects)

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The wide implementation in analytical practice of a complex of nuclear and isotope analytical methods being notable for high sensitivity and accuracy, large productivity and efficiency, profitability and simplicity of the analytical procedure, has great importance for many industries. On the one hand exact and operative knowledge of chemical composition of industrial products allows to keep the technology and the quality of production. On the other hand absence of infringements in technology conducts to a minimum of undesirable pollutions in the environment.

The nuclear and isotope analytical methods can be used also for the direct control of pollution both by continuous analysis and analysis of the selected samples.

The next nuclear and isotope analytical methods are most widely used:

- the method of activation analysis based on registration of induced activity, and methods of the analysis based on measurement of radiation, beginning as a result of nuclear reactions;
- the method of isotope X ray analysis based on interaction of radiation with electrons of internal shells of atom of analysed elements;
- the methods based on absorption or dispersion of neutrons, β- or γ-radiation by analysed substance.

Each of the specified methods has advantages and disadvantages.

The examples of use of these methods in real industrial conditions are considered in this paper for the purpose of both production control and protection of the environment.

Assessment of Drinking Water Radioactivity Content by Liquid Scintillation Counting: Set-up of High Sensitivity and Emergency Procedures

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Assessment of drinking water radioactivity content is a main topic both in normal and in emergency situations, as those arising from accidental and terroristic events. The evalutation of gross alpha/beta and individual radionuclides concentrations usually requires specific sample treatments, purification and measuring techniques.

In our institute a step by step procedure has been developed to measure the radioactivity content of drinking water by a single radiometric technique, namely low level liquid scintillation counting (LSC). LSC was equipped with an alpha-beta discrimination device and has been coupled to quick radiochemical procedures.

In emergency situations, a gross activity screening is carried out without any sample treatment by a single and quick liquid scintillation counting. A few bequerel per liter alpha and beta activity can be checked in 24 hours in more than one hundred samples.

More sensitive gross alpha and beta measurement can be performed on water samples after preconcentration by evaporation under controlled conditions. This procedure allows the determination of the actual gross alpha and beta activity of most drinking waters.

Total and isotopic uranium content is measured by selective extraction followed LSC. This procedure is less cumbersome than the traditional one (chemical separation followed by electrodeposition and alpha spectrometry) and allows evaluation of ^{234}U/^{238}U ratio. Then a quick check of depleted uranium contamination in a wide number of samples is also possible.

^{226}Ra and ^{228}Ra can be directly measured in a few mBq/l concentrations after specific concentration and purification steps. The procedure has proven to be quick and highly specific.

Our emergency screening procedure has been adopted by all district laboratories of Lombardia Environmental Protection Agency to face both accidental and intentional drinking water contaminations. High sensitivity gross alpha and beta, uranium and radium analytical procedures have been applied to the first extensive monitoring program of natural radioactivity in Lombardia drinking waters, in compliance with the most recent European Council Directives.

Reduced equipment requirements and relative readiness of radiochemical procedures make LSC an attractive technique, which can be easily implemented in new laboratories.

Determination of ^{210}Pb in Environmental Samples following different Procedures

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^{210}Pb is a natural radionuclide employed in many mathematical models to calculate accumulation rates. There are several procedures to quantify it in environmental matrices. Direct determination by gamma-spectrometry is the most common method, usually providing high associated uncertainties. Radiochemical procedures are more precise, but also more time-consuming and complicated.

In this context, a sediment sample collected in July 2001 from a salt-marsh in Doñana National Park (southwestern Spain), was analysed for ^{210}Pb following different procedures. The goal of this study was to statistically compare the results so-obtained, stressing the advantages and disadvantages of the methods used.

Briefly, the Marine Radioecology Lab from CIEMAT digested the sediment with a variable mixture of concentrated acids in a microwave oven. Lead was indirectly determined by quantifying the ^{210}Po in-growth by alpha-spectometry after a minimum waiting period of six months between the polonium autodeposits. Results indicated a mean ^{210}Pb value of 28±1 (n=4) Bq/kg±1s. The Environmental Radioactivity Lab from CIEMAT completely dissolved the sample with an acidic attack, followed by a microwave oven digestion of both the filter and the sediment residue. Lead was separated with an anion-exchange resin; then quantified as pure $PbSO_4$ deposited onto a stainless steal disc through the ß-emission of its descendant ^{210}Bi, approximately a month after their separation, with a Low-Level Proportional Planchet Counter. An average value of 31±1 (n=3) Bq/kg±1s was produced. Finally,the Physics Department Lab from UNEX digested the sediment on a hot plate with a mixture of acids. One part of the resulting solution, spiked with ^{209}Po, was used for polonium determination by spontaneous deposition and later alpha-spectrometry. The other part was analysed for ^{210}Pb, separating the lead by anion-exchange. Lead was finally quantified by liquid scintillation. A mean ^{210}Pb concentration of 33±3 (n=2) Bq/kg±1s was obtained.

Naturally Occurring Radionuclides in Thermal Swimming Pools of the Slovak Republic

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There are a lot of thermal water sources in the Slovak Republic. The main objective of the presented work was to determine naturally occurring radionuclides in thermal water sources mainly used for recreation and rehabilitation bathing. The concentration of U_{nat}, the volume activity of ^{226}Ra and ^{228}Ra and gross alpha activity and gross beta activity were carried out at 18 thermal water sources during the last two years. The concentration of U_{nat} ranged from < 1.5 to 6.1 $\mu g.l^{-1}$. The volume activity of ^{226}Ra ranged from 0.025 to 5.050 $Bq.l^{-1}$, the volume activity of ^{228}Ra ranged from < 0.08 to 2.66 $Bq.l^{-1}$. The gross alpha activity ranged from 0.03 to 22.28 $Bq.l^{-1}$ and the gross beta activity ranged from 0.04 to 10.22 $Bq.l^{-1}$. Calculations of ^{226}Ra and ^{228}Ra activity ratios were carried out as well.

Development of a Prompt-Gamma Neutron Activation Analysis Facility for Small Animal *In Vivo* Body Composition Studies using Am-Be Source

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The design, calibration, radiation dosimetry and preliminary performance evaluation of a prompt-gamma neutron activation analysis facility for *in vivo* body composition studies in small animals (i.e. rats or rabbits) are described. The system design was guided by Monte Carlo neutron and photon transport calculations performed using the MCNP-4C code. The facility utilizes a 555 GBq (15 Ci) Am-Be radionuclide neutron source positioned within a graphite collimator and appropriate shielding assembly. Prompt gamma rays produced by thermal neutron capture reactions within the animal are detected by a combination of a NaI(Tl) and a HPGe detectors positioned on either side of the sample, perpendicularly to the neutron beam. Small animal body nitrogen and hydrogen are determined by the NaI(Tl) detector by analysis of the 10.83 MeV and 2.22 MeV peaks, respectively, while calcium and chlorine are determined by the HPGe detector by analysis of the 6.42 MeV and 6.11 MeV peaks, respectively. Moreover, body potassium is determined independently by means of ^{40}K measurement at a modified whole body counter facility. Appropriate corrections for animal body size and shape are applied. Mixed neutron and gamma radiation dosimetry was performed using a tissue-equivalent proportional counter. The facility described is a simple tool enabling us to perform *in vivo* analysis of the major body compartments of protein, bone mass, extra-cellular and intra-cellular space. It will be used to perform serial nutritional and metabolic studies in sets of small experimental animals under controlled conditions for an ethically accepted radiation dose and without the need to kill the animal.

Large Sample NAA Facility at GRR-1 Research Reactor: Design and Applications

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A Large Sample Neutron Activation Analysis (LSNAA) facility is under development at GRR-1 research reactor, NCSR "Demokritos". The LSNAA facility design incorporates sample irradiation in the reactor's graphite thermal neutron column and subsequent measurement of the activity induced at a gamma spectroscopy system with gamma ray transmission measurement options included. Monte Carlo neutron and photon transport code MCNP-4C was used to model the facility. Appropriate correction factors accounting for neutron field perturbation during sample irradiation, high purity germanium detector efficiency for the volume source and gamma ray self-absorption within the sample itself were derived. The results of the computations were experimentally verified by activation foil measurements for a set of known materials and a range of sample sizes extending up to 10 litters. Moreover, the special issue of large sample analysis of non-homogeneous samples is examined and the limits of the technique are discussed. The LSNAA facility will be used to perform multi-element, non-destructive, contamination free analysis of large volume samples with high sensitivity and excellent sampling. End-users of the facility include archaeological, environmental, biomedical research laboratories and the industry. Preliminary results of large sample analysis are presented and the accuracy of the technique is validated against conventional instrumental neutron activation analysis of the same materials.

Investigation of Trace Element Atmospheric Pollution by Nuclear Analytical Techniques at a Global Scale: Harmonized Approaches Supported by the IAEA

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There are two conceptually different approaches for assessing trace element atmospheric pollution: (1) compositional analysis of directly collected APM, precipitation, and/or total deposit, and (2) the analysis of suitable air pollution bioindicators. In both approaches, multielement databases should be generated for subsequent emission source identification and apportionment. Nuclear analytical techniques are very suitable for the analysis of such kind of samples because they are multielement and non-destructive, having a high degree of sensitivity and selectivity for a large number of elements. For these reasons the International Atomic Energy Agency (IAEA) has been systematically supporting air pollution research since 1992.

As part of general support to improving analytical performance of laboratories in its Member States (MS) the IAEA has carried out several interlaboratory comparisons and proficiency tests on filters loaded with particulate matter, lichens and mosses. The results obtained over the years has showed a definite performance improvement in the laboratories carrying out such analyses. Some typical results are summarised and presented in the paper.

The IAEA has been supporting its MS' activities aimed at identifying major sources of air pollution affecting each of the participating countries and obtaining comparative data on pollution levels in areas of high pollution and low pollution. For these purposes an appropriate APM sampler was selected (about 100 such samplers have been distributed to nearly 50 countries worldwide), detailed sampling and sample preparation procedures elaborated, and data evaluation/interpretation procedures harmonized. The obtained results evidence that the levels of several pollutants (e.g. mass, S, Pb) in many countries exceed the United States Environmental Protection Agency prescribed limits.

The IAEA has also been co-ordinating development of biomonitoring metrology for assessing (trace) element atmospheric deposition using mainly lower plants. The developed methodology has been succesfully tested and applied in 14 countries worldwide and some key achievements are outlined in the presentation.

Use of Milk Progesterone RIA for the Monitoring of Artificial Insemination of Dairy Cows on Smallholder Farms in Turkey

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The technique of artificial insemination (AI) has been widely used in Turkey for several years to improve dairy cattle productivity. The fertility rate resulting from this technique is still low. The objective of this study was to identify causes of artificial insemination inefficiency on smallholder farms in Turkey.

The radioimmunoassay (RIA) for progesterone in milk samples collected from dairy cows on smallholder farms have been used for monitoring ovarian activity, diagnosis of pregnancy and non-pregnancy, assessment of the accuracy of oestrus detection and for surveying efficiency of artificial insemination services. All raw data were stored and analysed by the computer program AIDA (Artificial Insemination Database Application).

Milk samples were collected on day 0, days 10-12, and days 22-24 after artificial insemination from 220 dairy cows in 10 different regions. Based on the progesterone concentration in three milk samples, the reproductive status of the cows could be identified. Conception rate at first service was 63.0 % and overall conception rate was 70.4 %. The mean interval from calving to first service was 85.4 days and the mean interval from calving to conception was 96.1 days.

The progesterone concentration on the day of AI was negatively related to conception ($P<0.001$) and also associated with season. Incidence of incorrect artificial insemination, most likely due to erroneous heat detection, was 11.5%.

The results show that important factors affecting reproductive performance of dairy cows on smallholder farms include nutritional management, oestrus detection and season. The quality and efficiency of AI on smallholder dairy cows should be improved by using progesterone RIA.

Improving Tritium Exposure Reconstructions Using Accelerator Mass Spectrometry

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Exposure reconstructions are inherently difficult because measuring exposure levels after they occur is impossible. As a result, most reconstructions are based primarily on mathematical models of environmental fate and transport. These models can have large uncertainties, as important site-specific information is unknown, missing, or crudely estimated. Alternatively, surrogate environmental measurements of exposure can be used for site-specific reconstructions. In cases where environmental variables are complex, well-chosen environmental surrogates can have smaller exposure uncertainty than mathematical models. Because existing methodologies have significant limitations, the development or improvement of methodologies for reconstructing exposure from environmental measurements would provide important additional tools in assessing the health effects of chronic exposure. As an example, the direct measurement of tritium atoms by accelerator mass spectrometry (AMS) enables rapid low-activity tritium measurements from milligram-sized samples, which permit greater ease of sample collection, faster throughput, and increased spatial and/or temporal resolution. This method represents a new capability for environmental monitoring of tritium released into the environment. Tritium AMS was previously demonstrated for a tree growing on known levels of tritiated water and for trees exposed to atmospheric releases of tritiated water vapor. In these analyses, the ability to measure tritium levels in milligram-sized samples with sample preparation times of a few days resulted in the identification of spatial and temporal releases of tritium without the destruction of the tree. In addition, hundreds of samples were analysed within a few months of sample collection. As a result, such analyses may be important at other locations where tritium monitoring is occurring. Other environmental applications of tritium AMS are in tracer studies, either as an ideal tracer for water or a tritium-labeled molecule, where high-resolution samples from aqueous, gaseous, or organic substrates can be used to improve characterization. This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

Air Radon Concentrations in Tunisia – A Preliminary Study

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Radon, a radioactive gas, may be one of the causative factors for lung cancer. In Tunisia, air radon concentrations are still unknown.

We determined outdoor and indoor radon concentrations for the first time in different regions of the country, using open alpha track dosimeters containing a LCR 115 film.

The study of outdoor radon concentrations was limited to twenty different points, and lasted from February 1997 to April 1998. Each device has been exposed during three months.

Indoor radon concentrations were measured in two campaigns. During the first period extending from November 1999 and November 2000, measurements were performed in the capital. They concerned 67 dwellings in which dosimeters have been changed every two months. In the second period, determinations were made in seven hundred haouses scattered over the country. Each dosimeter was also exposed during two months, between January and March 2002.

The alpha track method was used to count the alpha particle impacts and the radon concentrations are expressed in Bq/m^3.

Our results show that the concentrations differed with the season and the location.

Medians for indoor and outdoor air radon concentrations have been calculated. Outdoor radon concentrations extended from 0 to 47 Bq/m^3. Most of the indoor radon results were less than 100 Bq/m^3 and in rare cases values were between 200 and 400 Bq/m^3. In Tunisia area, the highest rates were found in winter.

Considering all the results, the highest levels were detected in Jendouba, Gafsa and Tataouine “gouvernorats”. Lead mines are exploited in the first one and phosphate in the second one.

This preliminary work shows that air radon concentrations are low in Tunisia except in some localized points. Studies are going on in order to increase the number of measurements with a particular attention to the geology, the seasonal and atmospheric variations, the architectural type and the building materials.

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Behaviour of Gammaemitters, Sr-90 and Transuranic Elements in Forest Environment

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The behaviour of gammaemitters, Sr-90 and transuranic elements in forest environment was investigated in the close vicinity of the Finnish NPP's at Loviisa and Olkiluoto. Forest soils, lichens, mosses, ferns, bares, berries, leaves, needles and mushrooms were sampled and the distributions of different radionuclides in the species were measured.

Discharge nuclides originating from NPP's were detected only in one sample in Loviisa and in two samples in Olkiluoto. The global fallout from the nuclear weapons tests accounted for most of the Sr-90 and Pu-239,240 amounts. However, the effect of Chernobyl fallout could be seen in the ratio of Pu-238/Pu-239,240 in some of the samples. Most of Cs-137 related to the Chernobyl fallout.

Concentrations and distribution of radionuclides in soil samples were different in the two sites. Total amounts of Cs-137, Sr-90 and Pu-239,240 were clearly higher in Loviisa area, being 16 $kBqm^{-2}$, 0.7 $kBqm^{-2}$ and 50 Bqm^{-2}, respectively. Concentrations of Cs-137 in Parmelia physodes samples, which take up radionuclides mainly from air, varied largely (300 - 2700 $Bqkg^{-1}$) near to Loviisa in accordance with the unevenness of the Chernobyl fallout.

In plants excluding mushrooms, highest concentrations of Cs-137 and Sr-90 were found in Polypodium vulgare samples. Aggregated transfer factors (T_{agg}) from soil to Polypodium for Cs-137 and Sr-90 were in average 26 x 10^{-2} and 12 x 10^{-2} m^2 kg^{-1}, respectively. The results for mushroom samples scattered widely depending on species and growing site. The highest Cs-137 concentration was as high as 8500 $Bqkg^{-1}$ in a Hydnum rufescens sample. T_{agg}'s of mushrooms reached values up to 14 x 10^{-2} and 0.7 x 10 $^{-2}$ m^2kg^{-1} for Cs-137 and Sr-90. Needles of spruce appeared to accumulate more of Cs-137 than those of pine or leaves of birch.

As a whole, transfer factors of Cs-137 and Sr-90 were roughly of the same order of magnitude for plants and berries, while in species in which Pu-239,240 were detected, they were about two decades lower. Ferns turned out to be the most efficient bioindicators for all the radionuclides investigated.

Occupational Monitoring Programme of Uranium Concentrate Unit in Caetite, Brazil: Bioassay Programme

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The principal aim of the bioassay monitoring program in the Uranium Concentrate Unity in Caetite is the maintenance of acceptable safe and satisfactory working conditions, according to national and international norms. Specifically, the objective is to interpret measurements in terms of intake of uranium and committed effective dose, so that the results can be used to demonstrate compliance with the system of dose limitation and, mainly, the optimization of radiation protection. The employed technique is the measurement of uranium in excreta from workers in mine, crushing and uranium concentrate production areas.

The present work also aims at reporting the analysis results of incorporation of natural uranium, from bioanalyses of urine on routine for class y insoluble uranium (ore dust) and operational monitoring for class D solubility uranium (Ammonium Diuranate), and committed effective dose estimates of workers occupationally exposed.

In conclusion, workers from the mining and crushing areas should be monitored by the routine program; urine and feces samples should be analysed by mass spectrometry, with ICP-MS. The operational monitoring program should be carried out in workers from the uranium concentrate production area; urine and feces samples may be analysed by less expensive techniques.

For routine monitoring, based on the Mann-whitney Test, data from baseline monitoring were considered statistically equal to data from routine monitoring. Only three of out 24 workers showed results higher than the baseline, generating calculation of committed effective dose. However, none of them reached values bigger than those allowed to workers in Brazilian regulations.

For operational monitoring the same behavior described above is repeated, with baseline data considered statistically equal to operational monitoring, and only three out of 18 workers showed higher values in the operational monitoring. Once again values were within the limits established in Brazilian regulations.

Monitoring of Ra-226 an Ra-228 in Manioc (*Manioht utilissima*) and it's Flour in Uranium Mining in Caetité - Tropical Area in Brazil

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Tropical ecosystems have few developments from the radioecology point of view. In Brazil, radioecology studies had their development mainly in the 50´s decade, but a littke attention has been given to the radionuclides in food. The Uranium Concentrate Unit of 'Caetite' started operation in the 90's decade, and was preceeded by the environmental pre-operational monitoring program, carried out during 15 years (1982-1999), according to established licensing procedures, using biological samples from the human and animal food chain.

This work shows the results of last ten years of the pre-operational monitoring program of 'Caetite' in manioc (Manioht utilissima) and it's flour. The parameters studied are Ra-226 and Ra-228. Manioc (and it's flour) was chosen because of its role as the most important component of human food chain (82 kg/year for manioc and de same for manioc flour). This study was performed in 44 results of Ra-226 and 44 results of Ra-228 analyses, in 22 samples of manioc and 22 samples of manioc flour.

For the analysis, initially, the Anderson-Darling goodness-of-fit test for the maximum likelihood to the gaussian distribution is executed. With the data adjusted to the gaussian curve, an Analysis of variance (ANOVA) test is executed. If there is difference between concentrations, t Student tests are then executed.

The data have shown best goodness-of-fit to the log-normal distribution. After proper transformation ($y=\mathrm{Ln}(x+1)$), data have shown best goodness-of-fit to the normal distribution. The ANOVA test applied to normalized data have pointed differences in concentrations, that were identified by t Student tests as the Ra-226 values in manioc and the Ra-228 values in manioc flour. All other values are statistically equal.

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Determination of Metals and Gamma Radioactivity in Marine Algae from the Venezuelan Central Coast

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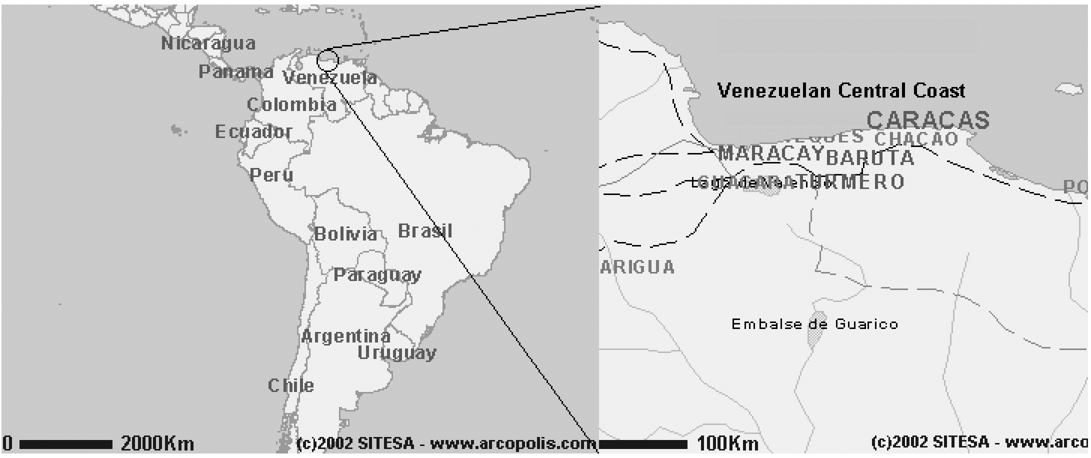
The Venezuelan central coast is located in the north part of the country, having a longitude of 65 Km. In this region are located La Guaira Port, important commercial exchange center since colonial times, Vargas state factory zone, and a multiple beaches which receive thousands of tourist per year. As a consequence of development of those activities ecosystem is in constant modification. Algae samples collected along Central Coast of Venezuela (see figure) were measured by Total Reflection X-ray Fluorescence technique (TXRF) and Gamma Spectrometry in order to determine metals and radionuclides levels. Metals levels measurements were carried out in a TXRF spectrometer with a molybdenum anode X-ray tube as a primary X-ray source and Si(Li) detector. Were found K and Ca as mainly elements (5-100 mg/g), Fe, Cd, Ag, Ti as minor elements (1-5 mg/g) and Cr, Mn, Co, Ni, Cu, Zn, Br, Pb as trace elements (10-600 μg/g). Gamma radioactivity analysis was carried out, measuring the activity of some antropogenic radionuclides, ^{40}K and radionuclides of the ^{238}U and ^{232}Th natural radioactive series. Samples were measured by high resolution gamma spectroscopy using a HpGe detector of approximately 2 KeV resolution for the 1,33 MeV ^{60}Co peak and efficiency higher than 20%. This Central Coast marine algae characterization allowed us to know about accumulation of metals and radionuclides (natural and antropogenic) in different types of algae, and the levels of such accumulation, which will be useful as reference for future investigations.



Instrumental Neutron Activation Analysis of Biological Materials using Research Reactors at BARC

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Instrumental neutron activation analysis (INAA) is a reference analytical technique that is extensively used for multielement analysis of reference materials and various samples. Use of high flux research reactors and high efficiency HPGe detector systems enhance the capability of INAA in terms of sensitivity as well as detection limit for many elements. We have standardized the k_0-based NAA method in our laboratory for multielement analysis using gold as the single comparator. Neutron spectra at E8 position of Apsara reactor and tray rod position of Dhruva reactor, Trombay, BARC have been characterized by determining epi-thermal neutron flux shape factor (α) and sub-cadmium to epi-thermal neutron flux ratio (f). We have used both relative and k_0 methods of INAA for determining elemental concentrations of three biological reference materials; SRM 1573a and SRM 1549 of NIST and CRM V-10 of IAEA. The INAA methods were used to determine multielements in five samples of total extracts of processed medicinal plants with an aim to correlating the curative values with the level of certain mineral content. The elements analysed included Na, K, Mn, Mg, Ca, Cl, Br, V, Al, I, La, Fe, Rb and Zn. The elements were determined via short, medium and long durations of irradiations. Short-lived nuclides were measured using pneumatic carrier facility (PCF) at Dhruva reactor whereas for medium and long-lived nuclides both Apsara and tray rod facility of Dhruva reactors have been used. The elemental sensitivity and detection limits for the elements analysed were arrived at using Dhruva reactor where the available neutron flux is in the order of 5×10^{13} n.cm^{-2}.s^{-1}, which is two orders of magnitude higher than the neutron flux available at the E8 position of the Apsara reactor. Accuracy of INAA methods was evaluated using NIST SRM 1515 and % deviation was found to be within ±10 % for most of the elements analysed.

Environmental Monitoring of Radioactivity Level in Qarun Lake

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This work aimed at measurement of natural and man-made radioactivity levels in Qarun Lake (one of the seven Egyptian Lakes) and calculation the population dose due to lake's fish consumption. Ninety bottom sediment, 44 shore sediment, 97 water and 35 fish samples were collected. The specific activities (Bq/kg) of ^{226}Ra (^{238} U) series, ^{232}Th series, ^{40}K and ^{137}Cs in all collected samples were measured using gamma-ray spectrometry based on hyper pure Germanium detector. The radium equivalent and ^{228}Ra/^{226}Ra and ^{226}Ra/^{238}U activity ratios for bottom sediment were calculated. The dose equivalent (μSv/y) due to ingestion of ^{226}Ra, ^{232}Th and ^{40}K in fish flesh were calculated. All measured and calculated results were discussed and compared with the results of other Egyptian Lakes.

Assessment of Occupational Exposure to Toxic Metals in Some Paint and Secondary Iron and Steel Industries in Lagos, Nigeria using TXRF Technique

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Lagos has remained one of the fastest growing cities especially in industrial infrastructure development. This has led to increased environmental problems. Yet there has been very little effort to monitor occupational exposure at various workplaces. Few selected paint industries and few secondary iron and steel industries in Lagos, Southwest Nigeria, were targetted for monitoring the heavy metal concentrations in their working environment.

Ambient air at strategic locations within selected industries was sampled for twelve hour periods during the day time and the night time. Sampling was done using a stacked "Gent" PM_{10} sampler and a twin-flow portable sampler, the latter for total suspended particulate matter. The filter holders were held at a height of 1.5 m above the ground. The filters were digested using ultra-pure acids and then analysed with a tube-excited Mo target x-ray source operating at 40 kV. Concentrations of toxic metal pollutants were measured using the total refelction x-ray fluorescence technique. Quantification of concentratins of toxic metals was done using QXAS analysis package from IAEA. Ga was used as internal standard in the analysis.

The elements of interest detected were Ca, Ti, V, Cr, Mn, Fe, Co, Zn and Pb. The ratios of the fine size fractions ($d_p < 2.5$ µm) to the coarse fractions (2.5 µm $< d_p <$ 10 µm) were determined for the elements detected. Concentrations for these elements range from 0.55 µg/m^3 to 36.2 µg/m^3 for the inhalable fraction. Toxicity potentials for the various elements were determined.

Studies on Mercury Contamination in the Brazilian Amazonic Region using Neutron Activation Analysis and Atomic Absortion Spectroscopy

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Intensive gold exploration activities started in Brazil in the 1980's, in the Amazonic region. Ever since, awareness of the general public and of the authorities has been growing, as to the dangers of environmental contamination by disposal of metallic mercury used for extraction of gold by amalgamation. It is estimated by Malm et al that around 2000 tonnes of mercury have been released in the Amazon in the last 20 years as a consequence of these activities.

In the framework of a Project developed at the Radiochemistry Division of IPEN/CNEN-SP (Brazilian Nuclear Energy Commission) and with support from the IAEA first as a part of a Coordinated Research Programme and then as a Technical Cooperation Project a nuclear analytical technique, instrumental neutron activation analysis, INAA ,was applied to the study of mercury contamination in Brazilian Indian populations living in the Xingu Park Indian reservation, located in the Amazonic region. Hair samples from the Indians and from a control population were analysed for total mercury and very high concentrations of mercury were found in the Indians, with means up to about 20 times that of the control population.

Following this work on analysis of hair samples of the Brazilian Indians, where the application of a nuclear technique allowed the analysis of mercury in about 400 samples, it is necessary to make a more complete study on this area, analyzing samples of fish and other foodstuffs consumed by the Indians, as well as soils and sediments of the region, in order to assess the sources of contamination. The hair samples of the Indians have been also analysed in this Project for methylmercury, a very toxic compound of mercury, which is able to surpass biological barriers like the placenta and cause severe damage to the nervous system of the fetus. With the collaboration of the Jozef Stefan Institute, of Ljubljana, Slovenia, methylmercury was analysed in many of the hair samples of the Indians, using another technique, atomic absorption spectroscopy, and it was concluded that most of the mercury was present in the hair as the dangerous methylmercury. It is known already that the most probable source of methylmercury for humans is fish ,due to the fact that they can concentratre methylmercury many times. Since the Indians consume fish on a daily basis, this could be the reason for the presence of very high amounts of mercury in their hair and also in their blood, as shown by other studies.

Instrumental Neutron Activation Analysis in Geochemistry. Emphasis on Spectral and Uranium Fission Product Interferences

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Since the advent of semiconductor detectors, several contributions to the INAA methodology allowed to resolve and analyse complex gamma ray spectra enhancing thus, the reliability of this analytical technique.

Despite attainable performances, some difficulties due to spectral and fission product interferences remain affecting thus the reliability of analytical results. A typical case is that discussed by Landsberger et al. [1] on the determination of Sm in the presence Gd, U and Th.

In practice spectral interferences in INAA are resolved by allowing shorter-lived radionuclides to decay and counting the remaining long-lived radionuclides. It is also proceeded to the substraction of contributions of interfering radionuclides using their interference free analytical photopeaks. Both of them are tedious and time consuming, particularly if radionuclides of interest have similar γ ray spectra, as is the case for ^{153}Sm and ^{153}Gd to which further interferences come from ^{239}Np and ^{233}Pa.

On the other hand, the presence of fissionable products such as U and Th in geological samples, and particularly in high grade U and Th samples, enhances difficulties in the accuracy attainable by instrumental neutron activation analysis. They give rise, during irradiation, to identical (n,γ) products from isotopes of natural elements.

The present contribution deals with 2 aspects of resolution of interferences in instrumental neutron activation analysis:

1. The application of a multicomponent method for the resolution of spectral interferences in gamma spectrometry using simultaneous equations method [2,3,4].

Assume m elements are to be determined by INAA whose (n,γ) products interfere at their n analytical γ-raies. An overall analytical response can be assumed to consist of several additive individual responses from m interfering radionuclides. The mathematical terms can be expressed by means of the following equation :

$$P^n = k + \sum a_i^n \, A_i \, \varepsilon_i$$

P^n = Photopeak area at the specific interfering n energy
k =independent term that accounts for a non-zero intercept.
a^n = γ-ray abundance of radionuclide i at the specific interfering n energy
A_i = absolute activity of radionuclide i
ε_i = Detection efficiency at the specific interfering n energy

Such a system may be expressed in a matrix form as :

$$P = \alpha \; x \; A$$

Once the matrix has been determined, one must calculate the absolute activities of interfering radionuclides.

2.The evaluation of fission product interferences in neutron activation analysis using the Erdtmann isotope-related k_i-factors [5].

These factors are derived from k_0-factors calculated only for important analytical energies of radionuclides, and have the advantage to be isotope-related factors instead.

Correction factors for U fission products identic to (n,γ) products are theorically evaluated calculating the equivalent mass of radionuclide produced by 1 μg of U fission reaction :

$$\frac{m_x}{m_{U_{nat}}} = \frac{k_{i,x}}{k_{i,U}} \cdot \frac{1 + R_0 \cdot Q_{0,U}}{1 + R_0 \cdot Q_{0,x}}$$

Correction factors are compared to those calculated using other formalisms discribed in the literature.

These interference resolution methods are applied to the analysis of uraniferous and phosphate ore samples by INAA.

The first method has been applied, for illustration, to the determination of Sm and Gd. These elements produce by (n,γ) reaction radionuclides ^{153}Sm and ^{153}Gd that have similar γ-ray spectra. Besides, the resultant spectrum is disturbed at their analytical photopeaks 97 and 103 keV, by the presence of ^{239}Np and ^{233}Pa.

The second method based on the correction of U fission product interferences is appiled to the determination of elements such as Zr, Mo, Ru, Ce, Nd and La whose (n,γ) are similar to those from U fission products [6].

Discrepancies in correction factors due to U fission products are noted for Mo-99 and La-140, especially with Erdtmann results. Imprecise nuclear parameter values available at that time account for such biased results.

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A Competitive Method for simultaneous Deuteron-Cyclotron Production of No-Carrier-Added Copper-64 and Gallium-67,66 for Applications in PET Radiodiagnostic and Metabolic Therapy of Tumours

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Copper-64 is a radionuclide suitable for labelling of radiopharmaceuticals for PET imaging, as well as metabolic radiotherapy of tumours. Among the several methods for production of *no carrier added* ^{64}Cu (^{61}Cu), we investigated the deuteron irradiation on Zn targets in the energy range up to 19 MeV with *simultaneous* production of ^{66}Ga, ^{67}Ga and ^{65}Zn, ^{69m}Zn.

The irradiations were carried out with the SCANDITRONIX MC40 cyclotron of the Joint Research Centre-Ispra (Italy) of the European Union, whose maximum energy is up to 19 MeV for deuteron beams.

Some thick targets (total absorption) were irradiated at the maximum energy to determine the thick target yield and to point out a selective radiochemical separation with quality controls of NCA ^{64}Cu from the zinc target and from NCA ^{66}Ga, ^{67}Ga. Moreover, the excitation functions in the energy range 3-19 MeV have been experimentally determined. In collaboration with ENEA of Bologna, Italy and the LLNL, USA it was possible to compare the experimental cross sections with the ones calculated with some computer codes and in particular with the results obtained with PENELOPE code and a new version of ALICE program.

At 19 MeV energy, an appreciable experimental thick-target yield of 8560 ± 240 MBq C^{-1} at the End Of an Instantaneous Bombardment (EOIB) is achieved. After a 25.4 hours irradiation (2 half-lives of ^{64}Cu) with a beam current of 100 μA of a thick Zn target of natural isotopic composition, could be produced theoretically 42 GBq of ^{64}Cu at the EOB. With present radiochemical yield of 80 %, the practical activity achievable for NCA ^{64}Cu (containing the shorter-lived ^{61}Cu) would be 34 GBq, that is an activity suitable for both PET imaging and radioimminotherapy of several patients. After a proper cooling-time, a ^{64}Cu with a radionuclidic purity suitable for high-resolution PET imaging is achievable.

Uptake, Retention and Organic/Tissue Distribution of ^{137}Cs by Japanese Catfish *(Silurus asotus linnaeus)*

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This works describes the uptake, retention/biological elimination of ^{137}Cs by Japanese Catfish *(Silurus asotus linnaeus)* under laboratory conditions. The fish were divided in to three groups viz. large, medium and small and reared in to the host water contaminated by ^{137}Cs. The accumulated ^{137}Cs concentration in the whole body of the fish was measured at certain intervals up to 60 days. A significant accumulation of ^{137}Cs was found but a steady state accumulation of ^{137}Cs was not achieved by the end of the experiment. The bioaccumulation factors and the distribution of the radionuclide in different organs/tissues of the fish were determined.

To determine the effective half-life, the fish were transferred and reared into the non contaminated host water. The concentration of the radionuclide in the whole body of the fish was measured up to 66 days. Neglecting the small first compartment for a few days, the average effective half-life of ^{137}Cs in the fish species was found to be ~ 30 days for all size of fish. Accumulation of ^{137}Cs in muscle/flesh of the fish was found to be ~ 75% of whole body accumulation.

Radiomonitoring of Radon in Seismoactive Zones of Azerbaijan

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Radon always exists in the atmospheric air. It is always exhalated into atmosphere out of the earth rocks as a result of fission of the uranium and thorium nuclei which exist in rocks and soils.

Radon exhalation into the atmosphere is characterized by the density of the current.

Amount of radon exhalating into the atmosphere depends on many factors. They are - amount of radioelements in rocks, porosity, permeability, humidity and so on. It also depends on meteorologic terms.

Radon exhalation is $(8 \div 20) \cdot 10^{-3}$ Bc/m^2 sec. out of recent deposits with the clark amount of radium. Above zones of tectonic dislocations and above earthquake centers radon exhalation is 3-4 times higher than in the environment.

It is known that faults control transportation of gases out of the earth interior to the surface. Faults are the most fluid permeable zones of the earth crust. Under the influence of contraction tension the tectonic faults become hydrodynamic draining systems related to the ascending fluid current in their vertical expansion.

Processes in the earthquake focus lead to the disturbance of the dynamic balance of the earth crust. This affected the atom field and the transportation of energy is wave-like without the diffusion current.

It was determined that in the subsoil air in the boundary with the atmosphere the amount of radon always exceeds its radioactive balance with radium. This provides a constant exhalation of radon.

Earthquakes intensify this effect and short-time anomalies appear. As the main deal of gamma-radiation of the earth crust falls to the after-radon short-living elements the increase of gamma-field level in the above-focus zone is a result of the radon field response to the energy of the seismic sources impact.

Analytical Quality Assurance/Quality Control of Nuclear Techniques within RER/2/004

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Quality assurance and quality control system was established to generate reliable results for research and routine service of nuclear analytical laboratories in Ankara. The technical and management requirements of international standard ISO 17025 was used to introduce and implement the quality system principles for self-sustainable formal accreditation. Methods for α/β,γ and X ray flourescence laboratories were improved and validated, uncertainities defined, and performance criteria tested. The importance of some characteristics for measurement such as repeatability, reproducibility, detection limits, control charts for critical technical variables and environmental variables were verified. In one frame of this project, to evaluate the participants performance in the determination of selected radionuclides of environmental importance and to validate the accuracy and precision of the measurements, two proficiency tests were carried out. Radionuclides in a spiked soil sample and in a standard solution were determined results of proficiency test are mostly compatible. Previous experience of nuclear analytical laboratories (γ, XRF and α/β) in center were focused on research and application of environmental topics. The present study is a part of model project of the IAEA, RER/2/004 entitled "QA/QC of nuclear analytical techniques" and expected to have economic and scientific impacts on trade, industry, environmental protection and life sciences.

Intakes of Radiologically Important Trace Elements from Iranian Daily Diets

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Cesium content and some more radiologically important trace elements were measured by nuclear and non-nuclear analytical methods in Iranian daily diets.This work carried out along with many more nutritionally important trace elements in a Coordinated Research Project (CRP) headed by IAEA. The study of Cesium could be important since it may include natural and artificial Cesium and a few more similar functioning elements such as Sr,Rb,I,Kand Ca. In particular,since the diets have been prepared almost simultanously by many investigators from various countries in different part of the world, therefore a comparable basis will be provided. The other importance of this work was the concurrence of execution of this study in 1986-1994 with the Chernobyl accident when the fall out of this nuclear accident enhanced the fission products on the earth .This is while at the same time, the diets were under preparation by participants in different countries. Though the ^{137}Cs and other radionuclieds were not measured in these diets under planned regular investigation by the most of participant countries but in compare with some other background, the contribution of ^{137}Cs in these daily diets/ total mixed diets may be estimated either by their concentrations or by the amount of intakes per person per day.Nevertheles the protection role of these trace metals in human organs is the main issue of this assessment. The matter regarding the origin of natural Cesium and radioactive fall out, as well as its effect on the foodstuff depend upon direct exposure or via the mineral and organic status of the soil, to transfer to nutritive species is to be discussed.

Sr-90 in Various Food and Foodstuffs

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Radioactivity in food and foodstuffs is a source of exposure that could significantly contribute to an increased internal dose of the population in cases of radiological emergencies, like nuclear accidents or radioactive discharges. Strontium-90 is an artificial radioactive isotope, produced by nuclear fission in nuclear energy plants and during the explosion of nuclear devices and weapons tests. Sr-90 is one of the most biologically hazardous radionuclides. After its introduction into the environment, it becomes incorporated into the calcium pool and the principal pathway followed to humans is from soil to plant to food. Drinking water and household water are potentially important pathways, directly or through their use in food preparation and processing. When entering the body, Sr-90 becomes distributed throughout the volume of the mineral bone, where it emits beta particles with a half-life of 28.8 years. It is therefore essential that the activity of Sr-90 in food and foodstuffs is controlled. This demands continuous surveillance to ensure that public safety targets and international commitments are met and ensure that the consumer and the environment are effectively protected. In this work we determined Sr-90 in milk, diary products, eggs, meat, fish, seafood, vegetables and potatoes. Special attention was paid to determination of Sr-90 in baby foods. Samples were collected in various regions and bought in shops in Slovenia. The strontium contents in various foodstuffs are in the range from 0.02 – 4.6 Bq kg^{-1}. The results show that the samples of selected food and foodstuffs commercially available in Slovenia contain low activities of the artificial radionuclide Sr-90 compared to the maximum permitted levels of radioactive contamination laid down in EU regulations.

IAEA Initiatives in Body Composition and Breast Milk Determination: examples from Ghana and Senegal

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Body composition can be measured by various techniques. However, The only way in which lean body mass and fat body mass can be measured accurately in free-living human subjects is to use a kinetic method with water labeled with ^{2}H and or ^{18}O. Known as the "stable isotope dilution method" this procedure is now accepted worldwide. In addition, This technique has been validated to assess infant milk intake. Indeed, the dose-to-mother isotope dilution method measures breast milk output and mother's body composition with minimum interference on the lactation process.The IAEA Technical Cooperation projects in Senegal and Ghana were aimed to estimate breast milk output and mother's body composition by deuterium dilution methods among lactating mothers beneficiary of the National Supplementary Feeding Programme. A dose of deuterium oxide was orally administrated to the mothers and saliva samples were collected from both the babies and the mothers before and after the administration of the dose. Enrichment of the saliva samples was measured by a fast, easy and less expensive method, which use a Fourier Transformed Infrared Spectrometer (FTIR).In Senegal, the study has been conducted on 206 women paired with their children and 1876 saliva samples have been analysed in duplicate. In Ghana, 150 paired-women with their children have been selected for the study and 2100 saliva samples have been analysed.

The results that came out from the both studies have shown that after three months of the supplementary feeding programme:

1. There is a significant increase in mother's lean body mass (41.35Kg ± 5.00) vs (34.63Kg ± 6.09) respectively in supplemented and non-supplemented mothers in Ghana. And, (40Kg ± 4) vs (37Kg ± 4) respectively in supplemented and non-supplemented mothers in Senegal.
2. Breast Milk volume increases significantly in Ghana's study (1050ml ± 280) vs (850ml ± 150). In However, in Senegal, milk output was not significantly improved by the intervention (992ml ± 186) vs (943ml ± 207) respectively in supplemented and non-supplemented mothers.
3. The nutrition intervention in both studies increases significantly the energy value of breast milk as well as zinc content.

In conclusion, the assessment of nutritional status of food supplemented lactating mothers using stable isotopes techniques showed that the intervention was beneficial to the community and the nutritional status of both mothers and children has been improved. In addition, The stable isotope dilution technique using the FTIR was accurate, reliable and easy to use for free living subjects in developing countries.

Advanced Nuclear Techniques for Health and Environment

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Particle accelerators were developed seventy years ago to investigate nuclear and atomic structure. Nuclear reactors were developed fifty years ago with the promise of producing low-cost energy and for military purposes. In the last three decades, we have witnessed a major shift towards the use of high energy ions from accelerators and high quality neutron beams from reactors in the analysis of materials composition and structure for a broad range of scientific applications.

Electrostatic accelerators have evolved into specialised tools for accelerator mass spectrometry (AMS) and ion beam analysis techniques. AMS is the technique of choice for the analysis of carbon-14 and other long-lived radionuclides in oceanography, hydrology, paleoclimatology and other environmental applications where isotope sensitivities of one part in 10^{15} are required. AMS is also applied in toxicology to study human exposure to chemicals and biomolecules at attomole levels.

Synchrotron accelerators fitted with insertion devices like wigglers and ondulators have revived interest in the field of hard x-rays microprobes. Recent developments are based on the use of Fresnel zone plates and tapered glass capillaries producing photon fluxes of 10^{10} photons per sec per μm^2 that allow minimum detection limits below 10^{-15} g, an ideal microanalytical tool for biology and materials studies.

Finally, high-flux neutrons produced by modern research reactors have unique properties for characterising the structure of matter in condensed states. In particular, small angle neutron scattering with cold neutrons is a versatile technique to determine microstructural features with dimensions in the range 10 to 1000 angstroms in biological, environmental and industrial samples.

In conclusion, ions, synchrotron radiation and neutron beams are increasingly used to probe materials structure and composition on the microscopic scale, each with their own range of applications, advantages and disadvantages. The information provided is complementary to that obtained using more conventional tools such as optical and electron microscopes or mass spectrometers. Examples will be taken from a diverse range of applications, including nutrition, toxicology and environmental science.

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Application of X ray Fluorescence Techniques for the Determination of Hazardous and Essential Trace Elements in Environmental and Biological Materials

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The utilization of X ray fluorescence (XRF) technique for the determination of trace element concentrations in environmental and biological samples is presented. The analytical methods used include energy dispersive X ray fluorescence (EDXRF), total reflection X ray fluorescence (TXRF), micro-beam X ray fluorescence and direct *in situ* X-ray fluorescence analysis. The measurements have been performed with X ray tube- and radioisotope-based energy dispersive X ray fluorescence spectrometers. Both liquid nitrogen- and thermoelectrically-cooled silicon detectors were utilized in the analysis. Samples analysed include soil, water, plant material, and airborne particulate matter collected on filters. Depending on the technique and the investigated elements, the above-mentioned samples were analysed either directly or indirectly (after decomposing the sample in a mineralization process or/and chemical preconcentration procedure). The achieved detection limits for different techniques, established by measuring appropriate reference standards, are presented. The utilization of the micro-beam XRF technique for studying element distribution in heterogeneous samples and investigating the 3D- and 2D-morphology of minute samples by means of computerized X ray absorption and X ray fluorescence tomography is described. The different X ray techniques have their unique advantages. The micro-beam X ray fluorescence set-up has an advantage of producing very well collimated primary X ray beam (by means of X ray capillary optics the beam is collimated down to about 15 µm in diameter), in front of which the analysed sample can be precisely positioned, providing local information about the sample composition. TXRF technique has its leading edge in analysis of liquid samples, and as a reference method for a conventional bulk EDXRF analysis of heterogeneous materials such as air particulates collected on filter where the particle size effects can seriously influence the accuracy of the analytical results. XRF spectrometers for *in situ* applications are truly portable and enable on-the-spot field analysis. It is shown that the combination of several XRF methods allows for a better characterization of a given material. In addition, the utilization of focused X ray beam brings additional information on the heterogeneity of the material and its morphology. Since, the utilized X ray techniques are optimized for different types of samples they can also be regarded as complementary methods allowing a variety of samples, e.g. solids, liquids, minute heterogeneous samples, to be analysed in one X ray fluorescence laboratory.

The Affectivity of Applying New Isotope Methods and Radiation Biogeocenology in Defining the Migration and Space Allocation of Radionuclides

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Syrdarya River is one of the two greatest rivers of Central Asia. Over 20 ml people live on its banks. Their lives and development have been depending on the river water for many hundred years already.

Intensive working out of mineral deposits while extracting the uranium concentrates with imperfect schemes of their processing (refining) was accompanied by waste accumulation. The great number of those waste depositories and refuses were placed to the benefit of doubtful economic interests in the valleys, channels and riverbeds of tributaries running into Syrdarya River.

In the town of Mailuu-Suu, situated in the middle flow of Maila-Suu River (Syrdarya tributary) there was extracted over 10 th tons of uranium concentrate for 22 years of uranium deposit exploitation. Total amount of accumulated in Mailuu-Suu radioactive waste is 2mln m^3 with the total activity of $5 \cdot 10^4$ Ku.

Approximate number of radionuclides, which are possible to get into Maila-Suu River and then into Syrdarya is $1.6 \cdot 10^{15}$ Bk, including radium $9.5 \cdot 10^{13}$ Bk.

Three back reservoirs with the total amount of radioactive waste of around 2mln tons and total activity of 10^{15} Bk are potentially dangerous sources of radioactive pollution of Naryn and Syrdarya Rivers [1].

Natural disasters may destruct the reservoir dams, cause the washing out the radioactive waste and pollute the water on the vast territory.

Organic matters of natural origin, i.e. humic and fulvic acids promote the formation of soluble complexes responding for high degree of uranium migration.

In respect of establishing the space allocation of radionuclides along the river flow, along the depth of bottom sediment, perspective is radiation biotechnology, the main purpose of which is studying the migration and accumulation of radionuclides in living and other components of natural ecosystems.

Dependence of radionuclides concentration in water on distance from the throwing down place is better described by the following equation:

$$K = e^{(a+bx)} \quad (1).$$

where K is radionuclide concentration; a, b are empiric coefficients; x is the distance from throwing down place.

Counting over the radionuclides contents in the water per 1 meter of river and taking into account the water volume in different sections with the help of (1), it is possible to define integral content of radionuclide in different parts of river.

For mountainous rivers of Central Asia method, based on the effect of ^{234}U and ^{238}U natural division and their correlation $\gamma = {}^{234}U/{}^{238}U$ provide wide perspectives to define the degree of pollution of river basins with technogen uranium.

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Use of PIXE, PIGE, XRF for the Decision of Ecological Problems in the NSC KIPT

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The National Science Center "Kharkiv Institute of Physics & Technology" (NSC KIPT) is the largest research establishment of Ukraine. Since 70 years in NSC KIPT nuclear-physical methods of analysis on beams of ions were developed. Now there are some electrostatic accelerators in the Institute that are used for the purposes of research of matter. The analytical complex "Sokol" is developed and built on the basis of the small-sized electrostatic accelerator on energy 2 MeV that is delivered to other organizations. Methods of PIXE, PIGE, RBS, XRF are used in NSC KIPT for solving many of problems; however, one of priority directions are ecological researches. Works on mapping bedrocks of some regions of Ukraine and Russia are ongoing; with such development, geo-information systems are now performed. Special interest is present in regions where large industrial targets or objects of nuclear power are located. In addition to element analysis radioactive nuclide samples of bedrock are investigated. The methodology of performance of work from sampling before realization of analysis and building of maps is described. Examples of performance of similar researches for concrete regions of the country are effected.

Investigations of some Core and Surface Sediments from the Black Sea by Radioisotope excited EDXRF and INAA Techniques

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In this paper we shall summarize our results obtained by radioisotope excited energy dispersive X ray fluorescence and instrumental neutron activation analysis techniques on the core and surficial sediment samples, collected from the Turkish coast of the Black Sea. Sediment samples, collected as gravity cores in depth from 70 cm to 150 cm, from the 20 sampling sites of the southern part of the Black Sea and surficial sediment samples, collected from 10 sampling sites of the Black Sea nearby Istanbul area in 1999 years were analysed by radioisotope excited EDXRF and INAA methods for Ca, Ti, V, Cr, Mn, Ni, Cu, Zn, Br, Rb, Sr, Y, Mo, Zr, Cd, Sb, I, Ba, La, Ce, Nd, U and Th elements. The investigated core sediment samples were the organic rich-mud components of the core samples, which were known as rich in metal concentrations. The C_{org} concentrations of the core samples were found from wet chemical analysis. In the case of EDXRF analysis, fundamental parameter technique was used and the pelletised samples were excited using an ^{241}Am source (10 mCi) and a HPGe detector or a ^{109}Cd source (25 mCi) and a Si(Li) detector with resolutions of approximately 350 eV and 185 eV FWHM, respectively, at 5.89 keV. In the case of instrumental neutron activation analysis, the samples were irradiated simultaneously with international reference materials at a fission spectra neutron flux of the density of $\sim 5.10^{13}$ $cm^{-2}.s^{-1}$ (WWR-SM nuclear reactor of Institute of Nuclear Physics, Tashkent, Uzbekistan). The gamma-spectra were measured by using gamma-spectrometer with the 100 cm^3 coaxial Ge (Li) detector (the resolution for 1332,5 keV line of ^{60}Co was ~3 keV). Investigation of the core samples results indicated the presence of some correlations between U and Mo and U and C_{org} concentrations. U is known to associate mostly with dead organic matter through adsorption and fixation. On the other hand, Mo is known to accumulate in the sapropel section of the cores, which is rich of organic matters. Thus U, C_{org} and Mo dependencies may be explained by accumulation of these elements in organic rich components of the sediment cores. The results of the surface sediments were compared with those from the heavily and moderately contaminated parts of the sea sediments. It is found that some elemental concentrations of the Black Sea sediments are comparable with those in most other sea sediments in the vicinity of densely populated regions.

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Improving Food Safety with accurrate Analysis by Laboratories participating in Proficiency Testing Programmes

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The certification of food products, either for export or internal consumption, requires an analysis as accurate as possible and proofs assuring that the results have a solid base. International food trade is a very sensible area of commerce and the sanitary barriers, including those for potentially toxic metals, are extremely strict. Countries with mutual recognition agreements (MRA) accept the certification of the exporter. Where MRA does not exist, the recipient country analyses the goods using their own sampling and analytical procedures. In some cases the results agree but do not in others. In the last situation the products are rejected and not allowed into the buying country with the consequent losses.

Chile has a large international market for its seafood products. It has to comply, however, with regulations established by each importing country. One such requirement refers to the maximum admissible level of cadmium in molluscs, set by many countries at 1 mg/kg of Cd. Discrepancies between the Chilean and laboratories abroad arose in the past, resulting in many rejections of the products. Under these circumstances, the Chilean National Fisheries (SERNAPESCA) and the Chilean Nuclear Energy Commission (CCHEN) set up a proficiency test programme mandatory for all authorized laboratories for the certification of export seafood. CCHEN has the responsibility of all technical aspects of the programme, including the preparation and distribution of the materials and evaluation of the results submitted by the participants.

After the first proficiency test, several laboratories had their authorization rescinded and, as an additional consequence, all the laboratories had to review and re-validate their analytical procedures. So far, three proficiency tests have been carried out and the response of the laboratories has noticeably improved with direct consequence in the decrease of rejections of the goods by the importers.

This paper presents the details of the CCHEN proficiency test programme, the results achieved and the plans for including other elements and foods to be exported by Chile in the future.

Radiotracer Techniques for Studying Pollutant Bioaccumulation in Marine Organisms

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Nuclear techniques can be used to improve our understanding of the processes involved in the transfer of radionuclides and conventional contaminants through coastal marine environments. In particular, the ability to radioanalyse live organisms and the increased sensitivity of radiotracer detection allows reducing considerably biological variation, measuring contaminant biokinetics over the long term in a limited number of individuals, and studying marine organisms and contaminant transfer mechanisms that can not be easily investigated using standard analytical techniques. This overview highlights some of the advantages of radiotracer techniques by illustrating three examples of studies carried out at IAEA-MEL.

Jellyfish is a primary example of organisms whose study involves several practical problems due to their gelatinous nature and high water content. Hence, data are extremely sparse on the bioaccumulation of metals and other contaminants in these organisms. The use of radiotracer approaches has allowed us to demonstrate that jellyfish readily take up heavy metals and radionuclides (e.g., Co, Zn, Ag, Cd, ^{137}Cs, ^{241}Am) both from sea water and food (CF up to 4×10^{2}) and efficiently retain them in their tissues (Tb½ up to several weeks). Given the fact that they constitute an important biomass in the oceans and are also efficient metal bioaccumulators, our results indicate that jellyfish likely plays an important role in the biological transfer and recycling of heavy metal contaminants in the marine environment.

Another example of a major constraint of classical analytical techniques is evaluating contaminant biokinetics over the long term. Using γ spectrometric techniques (Ge dectector), we were able to follow the heavy metal silver in a small number of crabs (n=20) that were allowed to ingest briefly (single feeding) shrimp previously labeled with ^{110m}Ag. Loss kinetics of ingested ^{110m}Ag followed in each crab for 4 months indicated that the turnover of silver assimilated by the organisms was extremely slow ($T_{b1/2}$ = 7.3 years), underscoring the usefulness of these crabs as an excellent long term recorder of silver contamination. Results also revealed that the assimilation efficiency (AE) of ^{110m}Ag was related to the sex of the crab; *viz.* AE was 71% in male crabs vs. 51% in females. All other biokinetic parameters were not significantly different between males and females.

High sensitivity of radiodetection may also be useful for investigating bioaccumulation of organic contaminants which occur at very low concentration, such as individual PCB congeners. Uptake of ^{14}C-radiolabelled PCB was investigated in two key echinoderm species, the sea star *Asterias rubens* and the edible sea urchin *Paracentrotus lividus* which were exposed to realistic PCB concentrations via sea water, sediments, or food. ^{14}C-PCB biokinetics for both species could be measured in individual organs, most of which are too small to be analysed by standard PCB measurement techniques. The radiotracer results showed that uptake was always the most efficient when organisms were exposed to PCB contaminated sea water. These experiments also allowed determining the main organs which bioaccumulate PCB and can be considered for monitoring purposes, *viz*. body wall and podia of sea stars and body wall and gut of sea urchins.

The usefulness of radiotracers to obtain rapid information on bioaccumulation and retention potential of contaminants and its application to monitoring and coastal zone management strategies are discussed.

IAEA's Contributions to Advances in Nutritional and Environmental Metrology

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The pursuit of identifying accuracy of analytical results with a clear insight into the sources of errors quantified as uncertainties is an essential component of metrology, the science of measurements. The measurement process itself is often benchmarked to a common reference point such as a certified reference material (CRM), a reference method or an SI unit to safeguard the traceability aspect as exemplified in the European Commission's document EUR 18405 (1998) on Metrology in Chemistry and Biology. In line with these thoughts, ensuring that analytical results generated in field studies meet the desired expectations has always been a great concern for the International Atomic Energy Agency (IAEA).

In the course of implementing a wide variety of projects over the years, the IAEA has gone through a process of continuous refinement, modelled on accumulating practical experience. The process, mainly operating through the IAEA's Co-ordinated Research Project (CRP) mechanism, is the result of a long and enduring learning curve for both the Agency and the participants, as numerous difficulties unfolded along the way. Thus the IAEA has consistently contributed in a practical way to strengthen the analytical competence in the nutritional and environmental areas, particularly in developing countries resulting in measurable improvements in the analytical quality of the results generated.

A sequence of examples spread over the past 3 decades illustrates the gradual positive developments in field studies and improved metrological profiles of analytical findings in the IAEA supported projects. For example, a CRP on trace elements in cardiovascular diseases initiated in the early 70s did not completely meet the set goals due to non-compliance in adopting harmonized sampling protocols and improper methods used for analysis. This led to enhanced focus by the IAEA on analytical quality assurance as a whole in the 80s resulting in the introduction of a range of diverse-matrix CRMs (e.g. total diet material, milk powder, among others). These efforts impacted positively on the results of another CRP on toxic trace elements in foods. However, data evaluation of this project revealed unsatisfactory variance in results although similar analytical methods had been used to analyse comparable food samples. Subsequently, in the late 80s the process of harmonisation of relevant parameters assumed importance leading to improvements in project protocol design, sampling and sample processing procedures, and validation of methods using matrix specific CRMs, among other measures. Innovative strategies implemented through the reference laboratory concept (same validated method used for a given analyte for all samples in a project) and the central laboratory concept (checking 10% of all samples of a project, while the participants' laboratories carried out the bulk of the work) for improving accuracy, yielded excellent results as witnessed in the CRP on reference asian man, and the data from the CRP on dietary intake of trace elements which were used for global recommendations by the WHO.

During the late 90s and the early 2000, metrological improvements have also been recorded for measurements of importance in human physiology. Examples are: harmonised measurements of bone mineral densities (BMD) using duel energy X-Ray absorptiometry measurements (two different modes, namely lunar and hologic) enabled comparison of BMD among 11 countries as seen from a CRP on osteoporosis; and CRP on ageing and obesity has identified systematic errors of over 10% in dietary energy intake by applying the doubly labelled water technique contributing to FAO/WHO/UNU deliberations for establishing new energy recommendations.

In summary, the numerous IAEA efforts supported by nuclear and isotopic techniques have collectively contributed to measurable improvements in the quality of analytical results of field investigations. In the stable isotope area, sources of bias in some conventional methods applied in human nutritional studies have been identified.

Analytical Techniques in Radiation Technologies

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Radiation processing which applies gamma, X rays , or fast electrons for inducing the changes in the material's chemical, physical of biological properties has been introduced in many fields. Quite a few applications are related to the health and environmental protection. Sterilization of health-care products and food irradiation belongs to the first group. The second covers flue gas and wastewater treatment .Radiation sterilization or food irradiation plants are in regular operation in many countries all over the world. Their role in medical hygiene, food borne diseases control, tissue banking can not be overestimated.Quality control is a very important issue concerning these processes; dosimetry, microbiology, content of pollutants and radiolytic products are all based on physico-chemical and biological analyses . Since the changes are very small and concentration of investigated substances very low, advanced or special development methods have to be applied. They concern photometry, ESR, luminescence and others. Regarding environmental protection, first introduced limits for emission of pollutants concerned gram quantities .Nowadays emission limits for sulphur and nitrogen oxides, small diameter particulate (smaller than 2.5 or 10 microns) are given in milligrams, while concentrations of heavy metals (including mercury) or polyaromatic hydrocarbons (i.e. dioxins) are in nanograms even. Therefore, monitoring techniques are of the biggest importance for implementation of radiation technologies for environment conservation. Two industrial plants for flue gas purification at coal fired power stations are in operation. The monitoring system for ppm's quantities of nitrogen and sulphur oxide, ammonium, ozone are substantial components of the system. The by-product being used as a fertilizer is controlled for composition and heavy metal content. The technology can be used for VOC and PAH (dioxins) control as well , HCPL/MS techniques should be used in this case and sampling is quite a sophisticated procedure. Stable isotope tracers are utilized to investigate process mechanism as well. Wastewater pollutants treatment plant using electron accelerator as a source of radiation has been constructed as well.HCLP/MS and other techniques are used to record performance of the plant. Solutions presented in the paper are the example of the role which analytical techniques play in modern technology development.

Sources of Environmental Radioactivity in Sediments of South of Gulf of Mexico

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Environmental radioactivity studies in sediments of the South of Gulf of Mexico were carried out to understand the distribution and concentration patterns of natural and artificial radionuclides in the Mexican marine sedimentary environment. These studies are unique in this area of the Gulf of Mexico. Twenty three USNEL BoxCores sediments were collected in water depths between 20 to 2000 m in the Southern Gulf of Mexico. The USNEL BoxCores sediments were collected aboard R/V Justo Sierra during the OGMEX XI, XII and XIII Oceanographic Cruises for the summers of 1993, 1994 and 1995. The 30-cm deep sediment cores were sub-sampled in 2-cm thick slides, and frozen for later analyses. The natural ^{40}K, ^{208}Tl, ^{214}Bi, ^{214}Pb, ^{212}Pb ^{228}Ac and artificial ^{137}Cs radionuclides concentrations were measured using a Ge-Li Hp Gamma-Spectrometer, and counting for 50-60000 seconds with ±5% uncertainty. The measurements were made at the Laboratorio de Vigilancia Radiologica Ambiental del Centro at Cienfuegos, Cuba.

On the basis of the measured natural and artificial radionuclides concentrations, three provinces were identified: continental shelf, continental slope and carbonate provinces. The distribution and concentration of natural radionuclides is a function of fluvial, fluvial-lagoonal sediments discharges, and horizontal circulation patterns (geostrophic) and wind driven circulation.

The highest natural radionuclides concentrations were found in sediments at water depths between 300 to 1500 m. This may be attributed to incoming Loop Current vortices which interact with bottom topography and collide with the western and southern Gulf of Mexico boundaries, decreasing their circulation energy and consequently allowing for the deposition of the natural and artificial radionuclides contained within the rings' water mass.

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Intrinsic Quality Assurance Aspects of Neutron Activation Analysis

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Neutron activation analysis (NAA) is an extremely valuable tool for the certification of Certified Reference Materials (CRMs) for a number of reasons. First, the method itself has characteristics that inherently provide few sources of error compared to many other analytical techniques. In addition, the intrinsic quality assurance characteristics of the method often allow the analytical values to be internally evaluated and cross checked. For example, most spectroscopic techniques separate the signals of the different excited species (analytes and interferences) by a single parameter, i.e. energy, mass, wavelength, time, etc. NAA can separate the signals of excited species (radionuclides) via two different parameters, energy and time (half-life). The ability to perform gamma ray spectrometry on the same sample after different decay times often provides the capability of verifying the absence of many sources of error such as interferences, incorrect pileup corrections, incorrect dead-time corrections, use of an erroneous half-life, etc. In addition, quantification using multiple gamma rays of the same isotope, and in some cases entirely different isotopes of the same element, can provide a powerful tool to minimize the possibility of errors due to interferences. Finally, counting both samples and standards at multiple geometries can provide insight into the importance of counting geometry effects. This presentation will describe ways to take advantage of some of the unique QA characteristics of NAA to observe and eliminate a number of potential sources of error.

The Relevance of Speciation to the Environmental Behaviour of Radionuclides

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Radionuclides exist in different chemical forms in the environment ranging from low molecular mass species such as ions, molecules and complexes to high molecular mass species such as colloids, particles and fragments. Furthermore, the physical characteristics of released radionuclides can vary considerably in morphology and structure, size, shape, density, valence and charge. For instance, a proportion of the radionuclides released from a nuclear weapons tests, routine discharges and reactor accidents are present as radioactive particles of varying size. Initially, radionuclide speciation is dependent on the source and release conditions. Once deposited, they can be transformed with time through interaction with various ecosystem components. Many studies have shown that differences in chemical and physical form can lead to varying environmental mobility and hence affect radiation doses. Low molecular mass species are reported to be more bioavailable and environmentally mobile than colloids and particles. Thus, to reliably predict the environmental impact of radioactive contamination of different ecosystems, we need to link information on radionuclide composition and speciation to an understanding of the influence this might have on environmental mobility. To do this, various techniques have been developed to estimate bioavailability of radionuclidies in soils and sediments, which often act as the major sink for radionuclides, and in plants. Here, I summarize current knowledge linking radionuclide speciation to bioavailability and then consider whether such information has been adequately integrated into currently available predictive models of radionuclide behaviour in the environment. The transfer of radioactivity to the milk and meat of farm animals is likely be a major exposure pathway of human populations, following an environmental release of radioactivity. As a more detailed example, the importance of source dependent bioavailability in determining transfer of selected radionucldies to animals is reviewed.

Mass Spectrometry for Nutritional and Environmental Applications: Recent Advances

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Mass spectrometry is an important analytical tool for monitoring the environmental pollution as well as for nutritional research. A variety of mass spectrometric techniques can be used in these research areas. The most commonly used are thermal ionization mass spectrometry (TIMS) and inductively coupled plasma source mass spectrometry (ICP-MS). In ICP-MS itself, various sample introduction techniques like pneumatic nebuliser, ultrasonic nebuliser, etc. are used. Also the ICP-MS instruments based on quadrupole analysers as well as sector field analysers are being increasingly used for various applications in environmental and nutritional sciences. Advances in electronics and computers have made these two techniques user friendly. Nevertheless, for utilizing the best potential of the commercially available TIMS and ICP-MS instruments, one has to critically carry out experiments, data collection and data evaluation. This becomes all the more important for environmental and nutritional applications where small changes in the isotope ratios must be determined with high precision and accuracy in the complex analytical samples keeping in mind the spectroscopic and non-spectroscopic interferences in the inorganic mass spectrometric techniques.

Changes in the Pb isotope ratios e.g. ^{206}Pb/^{207}Pb vs ^{208}Pb/^{206}Pb can be used to trace the origin/source of Pb contamination in the environment. Similarly, ^{87}Sr/^{86}Sr ratio gives information about the contribution from acid rain. Speciation studies on different elements like Pb, As and Hg are also essential to find out the concentrations of essential and toxic species of these metals. Use of stable enriched isotopes,e.g. of Fe in humans — in particular, in pregnant ladies, can be used to study iron eficiency anemia in developing countries. Similarly, the stable enriched isotopes of Ca can be used for studying osteoporosis in elderly persons. Many such examples exist in literature where the use of stable isotopes and mass spectrometry will play an increasing role in future for the nutritional applications.

Mass spectrometry has played a prominent role during the recent years in the characterization of a road dust reference material (BCR-723) for Pt, Pd and Rh. There has been an increasing concern in the concentration of these elements in the environment due to changes in the catalytic converter technologies. Various methodologies were adopted by different laboratories equipped with sophisticated ICP-MS machines and a number of problems was encountered during the determination of these PGEs in the dust sample. A few examples of various problems encountered and the methodologies resorted to in order to circumvent these problems would also be presented during the talk. A number of other elements including Pb have also been certified in the road dust sample.

Mass spectrometers are cost intensive and depend strongly on the expertise and experience of the trained manpower for obtaining precise and accurate data so as to arrive at meaningful results for various nutritional and environmental studies. In addition, ultra clean laboratories, ultra high purity reagents and the stable enriched isotopes to be used for isotope dilution are also required for performing these studies, which at times are not accessible to all the laboratories. Under these circumstances, IAEA can play a pivotal role by recognizing regional facilities as resource centres and strengthening them to assist their own country as well as countries in the neighbouring region.

Isotopic Techniques to diagnose Infection: with Special Reference to *Helicobacter pylori*

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The interest in *Helicobacter pylori* has not declined in these years. *H. pylori* causes a chronic gastric infection which is usually life-long and many epidemiological studies have shown that this is probably one of the most common bacterial infections throughout the world involving 30% of the population in developed countries and up to 70-90% of the population in developing regions. Thus, it is clear that the diagnosis of H. pylori infection represents at least a key step in the management of many of the patients referred to the gastroentelogist. Additionally, due to the wide range and relevance of pathologies possibly related to infection, including malignancies, there is the potential for *H. pylori* to be a major health problem. Improved methods for the diagnosis and follow up treatment of the infection have been developed in the last decades. The use of stable isotopes in non-invasive diagnostic methods, as the breath tests, was the key to a new era of research about *H. pylori* epidemiology, diagnostic, criteria for the eradication treatment, etc. This paper focuses on the different diagnostic methods employed, especially in those where isotopic techniques are applied.

Key words: Nuclear techniques, Isotopes, Diagnosis, Helicobacter pylori.

Prevention and Care of Osteoporosis in the Elderly: Nutritional Perspectives and Isotopic Tools

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Osteoporosis, a multifactorial disease, is characterized by reduced bone strength (bone-mineral density and quality) and proneness to fractures in post-menopausal women and the elderly above 65 years of age. Over 50% of osteoporotic fractures will occur in Asia by 2050. From prevention to treatment of osteoporosis, intervention should commence as early as childhood to optimize bone strength and preserve adult skeletal integrity, thereby reducing fragility fractures. Healthy lifestyles throughout lifespan including prudent diets, physically active and healthy body weight are important bone-strength modulators.

Calcium, vitamin D, phosphorus and protein, etc. and non-nutrients namely, phytoestrogens, caffeine and phytate, etc. have been shown to modulate bone integrity and bone loss. Supplementation studies with calcium and vitamin D on bone integrity have found positive effects on bone acquisition in growing individuals and retardation of bone loss in the elderly especially in populations accustomed to non-milk based diets. Bioavailability of calcium from non-milk based diets is largely unknown. If particular indigenous foods or calcium-fortified foods are proven with highly bioavailable calcium, dietary regimes based on the tested foods may be used in national campaigns to promote bone health and in diet therapy to retard bone loss.

Isotopic and nuclear techniques are indispensable tools to study nutrition and bone health: stable isotopic technique to evaluate calcium bioavailability in foods, calcium kinetics, absorption and retention studies in human, to monitor outcomes of bone strength and mineral deposition rate by using dual energy X ray absorptiometry and QCT, and to determine vitamin D metabolism and bone turnover rate by using radioimmunoassays in screening and nutritional intervention programmes.

To conclude, optimization of bone strength early in life and timely intervention on vulnerable groups in preserving bone integrity are important to reduce osteoporotic fracture risks. Isotopic and nuclear techniques are indispensable to accurately and precisely evaluate nutritional status and outcomes of bone strength in screening and intervention programmes for bone health.

Nutrient Fortification of Foods evaluated by Isotopic Techniques

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Deficiencies in micronutrients such as iodine, iron, zinc, folic acid and vitamin A - are widespread affecting more than a third of the world's population. In their absence, individuals and families suffer serious consequences including learning disabilities, impaired work capacity, illness and death. These deficiencies can be prevented and even eliminated if small quantities of the micronutrients are consumed by populations on a continuous and ongoing basis. The fortification of commonly eaten staple and processed foods with essential micronutrients could play an important role to meet the needs of large populations on a continuous and self-sustaining basis. There exist several opportunities for single and multiple fortification of several commonly eaten foods that include a range of staple foods and condiments such as cereal flours, oils and fats, salt and sugar. The universal iodization of salt is an example of successful fortification and impacts are already evident in several countries. The fortification of wheat and corn flours with iron, folic acid and other nutrients is also rapidly gaining acceptance in several countries in Latin America, Asia, the Middle East and North Africa. Fortification of sugar, oils and fats with Vitamin A is another option in several countries with well-documented impact. Nuclear and isotopic techniques can support food fortification programs in several areas including the testing of nutrient bioavailability to select the most effective forms, monitor nutrient content in foods and their impact on the micronutrient status of populations. Isotopic techniques based on stable isotopes of iron and zinc have been successfully used for tracking progress in food and nutrition development programmes in several countries.

Global Nutrition Issues: a WHO Perspective

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Hunger and malnutrition are among the most devastating problems facing the world's needy, and they are especially compromising for the health of the poorest nations. Millions are denied access to their fundamental right to adequate food and nutrition, and to freedom from malnutrition in its many forms. Food insecurity threatens 800 million people, many of whom depend on food aid for their survival.

There has been some measurable success in reducing the global burden of malnutrition over the last decade, with a slow but continuous fall in the prevalence of underweight malnutrition, iodine deficiency disorders, and vitamin A deficiency in children.

Nevertheless, malnutrition still kills, maims, cripples and blinds on a massive scale worldwide; it is both a major cause and effect – and a key indicator – of poverty and underdevelopment. Some 30 million low-birth-weight babies – 23.8% of the global total – are born every year, reflecting intrauterine growth retardation; fully 60% of the 10.9 million deaths among under-five children each year in developing countries are associated with underweight malnutrition; 161 million pre-school children suffer stunting (chronic) malnutrition; iodine deficiency is the greatest single preventable cause of brain damage and mental retardation worldwide; vitamin A deficiency remains the single greatest preventable cause of childhood blindness, and significantly increases morbidity and mortality; and immense problems of iron and folate deficiency, and resulting anaemia, affect more than 60% of women of childbearing age and millions of young children in developing countries, further increasing morbidity, mortality and developmental retardation in these already susceptible populations.

At the same time, in both industrialized and rapidly industrializing countries, a massive obesity epidemic is emerging among children, adolescents and adults, especially as a result of unhealthy diets and sedentary life-styles. More than half the adult population is affected in some countries, resulting in increased death rates from heart disease, hypertension, stroke, diabetes, some cancers and other chronic degenerative diseases. Many countries facing this nutritional transition of changing diets and lifestyles are weighed down by a dual burden of over- and under-nutrition in their populations.

WHO has a fundamental role in tackling these vast nutritional challenges by working with, and strengthening the ability of, Member States both to identify and reduce all forms of malnutrition, and to promote healthy nutrition and lifestyles. It calls for focusing WHO's combined nutritional programmatic and normative strengths through a vigorous outreach in regions and countries, as well as through strong collaborative action with the other key UN organizations such as IAEA, FAO, UNICEF, WFP, as well as others of the international community.

Translating this fundamental role into an effective practical strategy means for that – with varying emphasis, as determined by national and regional priorities – (a) reinforcing evidence-based action against maternal malnutrition, intrauterine growth retardation, and childhood and adolescent malnutrition; (b) improving growth monitoring and nutrition surveillance; (c) reinforcing national, regional and global action to improve infant and young child feeding; (d) monitoring progress towards eliminating iodine deficiency disorders and support universal salt iodization; (e) monitoring and combating vitamin A deficiency, anaemia and other widespread nutritional and micronutrient deficiencies; (f) developing global, regional and national strategies for preventing and reducing obesity and other diet-related diseases and for promoting healthy nutrition and lifestyles; (g) assisting Member States in strengthening their nutrition policies and programmes; and (h) supporting countries and front-line agencies in tackling nutrition and malnutrition in disasters and emergencies.

A Future for Nuclear Analytical Techniques? Why not?

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NAA and XRF are not anymore the only techniques for trace element determination in solid materials. Laser ablation high resolution ICP-MS and solid-state sampling AAS are now commercially available, which makes these techniques valuable work-horses in many fields of science. Laser-ablation ICP-MS has similar position-sensitive capabilities as most PIXE set-ups. In general, sensitivities with these techniques are often much better than with NAA and XRF, which enhances their attractiveness. And there are more dark clouds above nuclear analytical techniques. University research reactors face the closing of their facilities because of reallocations of university funds to more contemporary sciences such as molecular biology and nanotechnology. Several pioneers in NAA have already publicly turned their back to technique as being mature, without scientific challenges and for loosing ground even for routine applications. Their view can not entirely be denied since the scientific creativity of many groups operating NAA, XRF and PIXE do not bring them further than applications in the same fields as in which these pioneers demonstrated these techniques long ago: air pollution studies, sediment analyses, hair analysis, etc. The social-economical impact of these fields is in general too low to obtain respect and sufficient financial resources for survival. Moreover, scientific publications on these applications are mostly in journals with low science citation impact factors.

Laboratories operating nuclear analytical techniques (NAA, (TR)XRF, PIXE) need to use their creativity in finding ways for participation in the scientific areas that are booming at the beginning of this 21st century such as nanotechnology, cancer research or genomics. It requires an open mind on the strengths and weaknesses of the techniques, and a departure of traditional views on measurement, analysis and even (for NAA) on other sources for activation. The unique features of using radiotracers and activatable tracers need again to be explored. New strategies are also needed for outreach and publications. Some examples of opportunities for nuclear analytical techniques in the above mentioned modern fields will be given. This contribution is meant to evoke the various groups that are (still) active with these techniques.

Simultaneous Speciation Analysis using Neutron Activation

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Neutron activation analysis (NAA) is a well-established analytical technique for the simultaneous determination of multielement concentrations. Although various forms of NAA have been traditionally applied to measuring the total concentrations of elements, the scope of NAA can be further extended in conjunction with pre-irradiation chemical separations to determine the species of an element. The technique can then be called speciation NAA (SNAA). Since much of the toxicity of an element depends on its physico-chemical forms, there is an increasing interest in studying its speciation. A number of characteristic features of NAA, which other techniques normally do not possess, can be advantageously exploited in SNAA. For example, SNAA has simultaneous multielement specificity unlike AAS and AFS. The SNAA technique can be applied to the simultaneous speciation of elements which are not chemically similar such as Cd, Se and I, as well as to the elements such as Cl, Br and I which are rather difficult to determine by most other techniques. Qualitative as well as quantitative analysis of small samples can be done by SNAA with excellent precision, accuracy, sensitivity, and rapidity. Unlike many other techniques, SNAA has some enhanced quality assurance capabilities. We have developed SNAA methods for separating various inorganic and organic arsenic species in water and in seafoods. We are presently extending these methods to include simultaneous speciation of As, Sb and Se. We have also developed SNAA methods employing biochemical techniques for the characterization of metalloproteins and protein-bound trace element species of Se along with Cd, Cu, Mn, Mo and Zn in bovine kidneys. Lately, we have concentrated our efforts to develop SNAA methods in conjunction with HPLC, RPC, SEC, NMR and MS for the simultaneous separation and characterization of extractable organochlorine, organobromine and organoiodine species in fisheries samples. An overview of the methods will be presented.

POSTER PRESENTATIONS

Routine Monitoring of Nutrient Elements in Market Milk by INAA Technique

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Products and services marketed to the public are expected to meet certain standards. The issue of standards and national economic development cannot be separated because they promote quality within the economy and inspire confidence in both manufacturer and user. Because of lack of adequate quality control and monitoring measures by regulatory and standard agencies, fake and substandard products find their ways to the Nigerian markets. The principal reason for this is that these agencies do not have access to multi-elemental analytical tools that can handle the large sample throughput involved in such routine checks. In this work, the instrumental neutron activation analysis technique (INAA) with thermal and epithermal neutrons from a 30 kW research reactor has been used to determine the concentration of some essential elements in powdered milk products. The elements Ca, Cl, Fe, Mn, Mg, K, Na, V, Zn, Br and I were found in various proportions in eight widely consumed powdered milk products in Nigeria. A comparison of the measured results and producer's quoted values indicates that the adopted experimental procedure can be used routinely for control and monitoring purposes. This work was carried out vis-à-vis the installation of a commercial miniature neutron source reactor at the Centre for Energy Research and Training, Ahmadu Bello University, Zaria, Nigeria under an IAEA project.

Assessment of Natural Radionuclide Levels in Pakistan Foodstuffs and associated Radiation Doses

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A comprehensive study has been carried out for the assessment of the contents of natural radionuclides (^{40}K, ^{238}U, ^{226}Ra, ^{228}Ra, ^{232}Th, and ^{210}Pb) and related radiation doses in Pakistani food items (fruits, seasonal vegetables, beef, mutton, poultry meat and eggs) and drinks samples (milk, tap water and soft drinks) using high resolution gamma spectrometry.

For detection analysis and data acquisition a high purity germanium (HPGe) detector was used. All the food items and drink samples showed detectable ^{40}K activity, however, most of the other natural radionuclides in solid food were found to have contents below the minimum detectable activity (MDA).

The range of ^{40}K activity was found to be 9.2 to 110.5 Bq kg^{-1} for solid food and drink samples. The cumulative average value of ^{226}Ra activity was found to be 1.2 Bq kg^{-1} in all the leafy/seasonal vegetables and fruit samples including turnip, potatoes, tomatoes, onion, brinjal, spinach, cauliflower, pumpkin, carrot, radish, cabbage, peas, cucumber, ladyfinger, beat, pepper, apple, banana, melon, mango etc. and 0.35 Bq kg^{-1} in beef, mutton, poultry meat and egg samples.

In all water based drink samples the measured values of the mean activity of ^{238}U, ^{226}Ra, ^{228}Ra, ^{232}Th, and ^{210}Pb were 0.22, 0.015, 0.026, 0.018 and 0.19 Bq kg^{-1} respectively. The annual effective dose due to the ingestion of these radionuclides was estimated to be 0.5 mSvy^{-1} from solid food and 0.3 mSvy^{-1} from drinks. These values are quite below than the upper limit of 1 mSv as specified by ICRP recommendations.

The contribution from these radionuclides does not pose any significant radiological health problem to the general public. This study also provides baseline values and general background of the natural gamma emitting radionuclides in Pakistani foodstuffs.

Radon-222 in Outdoor Air in the Finnish Arctic

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The Finnish Meteorological Institute has been measuring airborne radon-222 at its air quality monitoring station at Sevettijärvi, Northern Finland (69°35'N, 28°50'E) since 1995. The ^{222}Rn content of the air was monitored continuously by counting the beta particle emissions of the particle-bound daughter nuclides ^{214}Pb and ^{214}Bi collected onto glass-fibre filters.

The observed ^{222}Rn activity concentrations in the air were lognormally distributed. The diurnal variation of the ^{222}Rn concentrations was relatively large in August and September due to simultaneous strong radon exhalation and frequent nocturnal surface inversions. The lowest concentrations were measured in May, when the snow cover hinders the exhalation of radon and the almost continuous solar radiation causes efficient vertical mixing of the lower troposphere. In winter, during the polar night, the ^{222}Rn concentrations are high because of the stagnant conditions of the surface air.

To identify the source areas of ^{222}Rn the observed afternoon concentrations were connected to concurrent air mass back trajectories calculated with the computer code TRADOS. As expected, the highest ^{222}Rn concentrations were found in air masses coming from north-west Russia and the lowest concentrations in air masses coming from the Barents and Norwegian Seas. However, unanticipatedly high concentrations were found in air masses from the area between the 70th and 80th latitude over or near Greenland indicating a slight contribution from North America. A comparison to observed atmospheric sulphur dioxide concentrations indicates that the mining and metallurgical industry at Kola peninsula does not cause any technologically enhanced ^{222}Rn concentrations in Northern Finland.

Tracing of Mercury Sources in Nahuel Huapi National Park, Patagonia, Argentina, using Lichens as Atmospheric Bioindicators[*]

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Usnea sp lichens were analysed in order to asses atmospheric sources of mercury in Nahuel Huapi National Park, Northern Patagonia, Argentina. Previous studies had shown that mercury contents in sediment and biota are high considering that within, or nearby, the region of study no relevant industrial or extensive agriculture activities exist.

Pooled samples, made of at least 10 individuals, were analysed by Instrumental Neutron Activation Analysis. Sampling sites were defined following the steep precipitation gradient of the region, that ranges from 3000 $mm.y^{-1}$ in the Western part of the park, to 500 $mm.y^{-1}$ in the Eastern. Lithophile elements, associated with particulate matter entrapped by the lichen thalli, were identified, but mercury was not among these elements. Mercury contents range from (0.0558 ± 0.0083) to (1.38 ± 0.18) $\mu g.g^{-1}$.

The analysis of mercury contents determined in foliose lichens sampled from urban and periurban sites of Bariloche city, single relevant human settlement in the park, and from undisturbed regions, showed higher mercury contents in Bariloche air than in the surroundings. Transplanted thalli of fruticose *Protousnea magellanica* from undisturbed zones to urban sites confirmed this conclusion.

^{137}Cs cumulative fluxes in the region were also determined from inventories of lake core sediments sampled nearby lichens sampling sites. Global transport followed by wet deposition is a potential source of mercury, and ^{137}Cs is an anthropogenic isotope that can reach the Nahuel Huapi National Park only by atmospheric transport, stratospheric or tropospheric. *Usnea* sp mercury contents do not correlate with ^{137}Cs cumulative fluxes along the precipitation gradient, leading to the conclusion that global transport and wet deposition is not the main mercury source in Nahuel Huapi National Park, and the analysis of the results suggests that more than one source are combined to impact the whole park area.

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[*] This work was performed within IAEA Technical Co-operation Project ARG/7/006 "Investigation of mercury and other heavy metals in water bodies of Nahuel Huapi National Park, Argentine Patagonic Andean Range. Base lines determinations, trophic web pathways investigation and contamination source identification".

Heavy Metals Bioindication in Northern Patagonia Lakes, Argentina, using Native Mussel *Diplodon* sp[*]

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Native mussels *Diplodon chilensis* were sampled from lakes comprised in Nahuel Huapi National Park, Northern Patagonia, Argentina, and surrounding areas, in order to evaluate heavy metal distribution in the region, and to assess the contribution that this compartment of the trophic web transfers to the circulation of these elements in the food chain. Filter feeding organisms such as the hard shell *Diplodon chilensis* are ideal subjects for the study of bioaccumulation of contaminants in view of their feeding habits which imply that they become key link elements in the transfer of energy in the form of phyto, zooplankton and organic particulate matter from the water column into the water bodies food webs.

The concentration of potential pollutants or elements that could affect human health or wild-life, namely Sb, Ag, As, Cr, Hg, and Se were determined in pooled samples of 15 similar length individuals, by Instrumental Neutron Activation Analysis. Digestive glands were analysed separately from soft tissues. Geological tracers Sc, Ta, Th, U, and Rare Earth elements, were also determined in order to discriminate the elements associated to detritical particulate matter included in mussels bodies from those incorporated by the organisms. No relevant differences were observed between elemental concentration in digestive glands and whole soft tissues except for Hg contents, that ranged from 0.7 to 12 $\mu g.g^{-1}$ dry weight in digestive glands, and from 0.2 to 0.9 $\mu g.g^{-1}$ dry weight in whole soft tissues. There was no correlation between Hg contents in both types of samples. Whole soft tissues were selected for long-term bioindication since the time residence of Hg in digestive gland is shorter and could not represent steady state conditions.

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[*] This work was performed within IAEA Technical Co-operation Project ARG/7/006 “Investigation of mercury and other heavy metals in water bodies of Nahuel Huapi National Park, Argentine Patagonic Andean Range. Base lines determination, trophic web pathways investigation and contamination source identification”.

Biomonitoring of Trace-Element Air Pollution in a Gold Mining Area in Ghana using the Generalized k_0-standardization NAA method

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Mining activities contribute immensely to trace element atmospheric pollution. In Ghana, air pollution due to gold mining is the least investigated. In order to obtain preliminary information on air quality in the mining areas, the generalized k_o- Standardization neutron activation analysis (NAA) method for nuclides following "1/v" and non-"1/v" (n,γ) reactions was used to analyse lichen samples from Prestea, a gold mining area in Ghana. Using the computed EPI values of both the Hogdahl-convention and the modified Westcott-formalism with gold as comparator standard, the IAEA lichen 336 certified reference material (CRM) and the lichen samples were irradiated in the inner irradiation site of the Ghana Research Reactor-1 (GHARR-1) operating at a thermal neutron flux of $5.0\text{x}10^{11}\text{ns}^{-1}\text{cm}^{-2}$. Comparison of the results with samples obtained from a non-mining (control) area, indicates that values of some metal pollutants such as As, Cr, Sb, and V were found to be higher in the lichens from the mining area than those in the non-mining area (control area); signifying accumulation of these metal pollutant due to gold - mining activities.

INAA Applications in the Age Dynamics Assessment of Ca, Cl, K, Mg, Mn, Na, P, and Sr Contents in the Cortical Bone of Human Iliac Crest

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Senile osteoporosis and particularly osteoporosis among postmenopausal women represents an urgent problem of modern medicine.

The effect of age and sex on chemical element contents in intact cortical bone of iliac crest of 80 relatively healthy 15-55 years old women (n=36) and men (n=44) was investigated. All subjects had died suddenly and bone samples were obtained at necropsy from the right side within twenty-four hours after death. A tool made of titanium and plastic was used to clear samples from soft tissues and blood and to cut cortical part of bone. The IAEA and NIST reference materials (H-5 animal bone and SRM1486 bone meal) were used to estimate the precision and accuracy of results.

Contents of Ca, Cl, K, Mg, Mn, Na, P, and Sr in intact bone samples were determined by instrumental neutron activation analysis using short-lived radionuclides. Our mean data for each element of reference materials were within the certified 95% confidence interval, and indicate an acceptable accuracy of the obtained results.

Mean values (M ± S.E.M.) for mass fraction of the investigated elements (on dry weight basis) for female and male all together were: 20.8 ± 0.3%, 1390 ± 55 μg/g, 746 ± 41 μg/g, 2070 ± 65 μg/g, <0.36 ± 0.02 μg/g, 5590 ± 1200 μg/g, 9.53 ± 1.7%, and 308 ± 18 μg/g respectively. The contents of elements such as Ca, Mg, and P in the cortical iliac crest tend to decrease with age to a certain degree for both women and men. This tendency is more pronounced for men. Sex-related comparison did not show any differences in Ca, Cl, Mg, Mn, Na, and Sr mass fractions. Statistical little significant ($p \leq 0.05$, t-test) higher mass fraction of P in the female and K in the male cortical iliac crest were found.

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A Field Method for Assessing Body Composition by Portable XRF Bromine Analysis: Validation Against Instrumental Neutron Activation

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Extracellular water space (ECW) is expanded in acute illness or in catabolic states. The assessment of change in ECW provides a simple method for monitoring nutritional status. ECW can be measured by Br dilution. A small amount of natural Br (10-17mg per Kg of body weight) is given orally. The concentration of Br in plasma is measured prior and 3 hours following the administration. Plasma is analysed for Br either by ion-exchange chromatography, or by non-destructive methods, such as instrumental neutron activation analysis (INAA) or X-ray fluorescence (XRF).

We developed a method for the rapid analysis of Br in plasma with a small hand-held, XRF instrument consisting of a 30mCi Cd-109 source and an electronically-cooled solid-state X-ray detector. 128 plasma samples were analysed from 64 volunteers aged 19 to 84y. The samples were measured first with the XRF instrument and then by INAA using the nuclear reactor of the research center "Democritos" by the $^{79}\mathrm{Br}(n,\gamma)^{80}\mathrm{Br}$ neutron capture reaction. The samples were exposed to 2×10^{13}n/cm^2/s for 3 min. Detection of the ^{80}Br ($t_{1/2}$= 17.8 min) gamma-ray (616.2 KeV) followed 3 min after the irradiation using a liquid nitrogen-cooled purified Ge photon detector.

We found the XRF instrument to be highly correlated with the neutron activation measurements (R= 1.000 for 7 standards, R = 0.997 for human plasma samples). We also observed that, in our group of volunteers, ECW was able to assess nutritional status as determined by in vivo neutron activation analysis. This simple method makes body composition measurements widely available as the main outcome of nutritional and pharmaceutical anabolic interventions.

High-Accuracy Method of Molybdenum Determination in Biological Materials by RNAA

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Molybdenum is one of essential trace elements whose biological function is still a matter of dispute. The determination of molybdenum traces in the material of biological, especially plant origin is a difficult analytical task. The previously published method for the determination of Mo in biological materials — based on neutron activation analysis, ion exchange and extraction column chromatography — has been further refined in order to obtain the high accuracy, for the materials of both: plant and animal origin.

As it has been proven the weak point of the procedure was not always adequate correction for contribution of uranium fission reaction, depended on position of a particular sample in the irradiated package. The determination of uranium was incorporated in the proposed radiochemical procedure and the contribution of uranium fission interference reaction was strictly monitored, therefore the proper correction of the results was able to be introduced.

Usefulness of various techniques for sample decomposition has been assessed by comparing the results for molybdenum in several CRMs. A microwave digestion was used as a method of choice.

The aforementioned innovations allow to minimalise the uncertainty of the obtained results, classifying the proposed method as a method of high accuracy, able to serve as a reference method, a useful tool in the certification of reference materials. The method can be successfully applied to various kinds of biological materials, including biological products for human and animal use.

Radioecological Situation in Montenegro

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The Center for Ecotoxicological Researches realize the Republic program of sistematic survey of radionuclide contents in the environment of Montenegro. These measurements showed that radioecological situation in Montenegro is quite good.

Everyday measurements of absorbed doses in air in the town of Podgorica give results on level of natural radiation background, and all measured concentrations of radionuclides in air and in fall-out in Podgorica have normal values.

Radionuclides in water of the Scadar Lake and in sea water near the town of Bar and town of Herceg Novi have concentrations even less than maximum permitted ones in drinking water. This should be stressed because of a rumor that our sea water is radioactively contaminated, which appears before and during summer touristic season.

Concentrations of radionuclides in drinking water of the public pipeline in Podgorica are far below the permitted maximums. Analysed samples of the different kind of food produced in Montenegro showed good radiological quality.

Soil samples taken from the area of Podgorica have an usual content of radionuclides, and samples of surveyed building materials that is produced in Montenegro satisfy the regulations for permitted radioactivity.

Radon Concentration, absorbed dose rate and surface contamination were measured in dwellings and workplaces in Podgorica. Radon is surveyed at 33 locations, four times during the year. Among locations where radon reference level was exceeded, unfortunately are some number of children gardens.

Rapid Determination of Artificial Alpha Nuclides with Long Lives using Time Interval Analysis Method

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Introduction

The monitoring of long lived alpha radionuclides such as plutonium (^{238}Pu, $^{239+240}$Pu) is extremely important around working area of nuclear fuel cycle facilities, because potential risk of cancer-causing from alpha radiation at the internal exposure is well-known to affect highly rather than that of gamma radiation. From this situation, the monitoring of α emitters requires high sensitivity, high resolution and rapid procedure even in very low-level concentration. Activities from natural radionuclides, including radon (^{222}Rn or ^{220}Rn) and their progenies, should especially interfere the highly sensitive monitoring of artificial α emitters. Such interfering signals could be excluded as low as possible by applying time interval analysis (TIA) of pulses.

Principle

A sophisticated discrimination method between artificial α emitters like Pu and progenies of ^{222}Rn or ^{220}Rn as natural radionuclides using time interval analysis (TIA) [1,2,3], could be attained. The components of artificial α emitters could be evaluated by subtracting short-lived natural RI-components, based on the TIA-calculation of successive alpha and beta decay events within millisecond or microsecond orders, from whole decay events. In TIA-counting system, alpha rays from ^{214}Po, ^{216}Po and ^{212}Po with short lives are selectively extractable. The TIA measuring system composes of a silicon surface barrier detector (SSD), an amplifier, an analog to digital converter (ADC), a multi-channel analyser (MCA), a high-resolution timer (TIMER), a multi-parameter collector and a personal computer. In the ADC, each incident alpha and beta pulse is sent to the MCA and the TIMER simultaneously. Pulses from them are synthesized by the multi-parameter collector. After measurement, natural radionuclides are subtracted.

Results and Summary

Airborne particles were collected on membrane filter for 60 minutes at 100L/min.. Small Pu particles were added to the surface on the filter. Alpha and beta rays were measured by the SSD following to TIA-processes, so that the signals due to natural radionuclides were subtracted by fixing the dead time of five times of 145msec.by TIA. As a result, a trace amounts of Pu-component hidden in natural background spectrum could be clearly revealed.

The lower limit of determination of ^{239}Pu is estimated to be 6×10^{-9} Bq/cm^3. This level is satisfied with the derived air concentration (DAC) of ^{239}Pu (8×10^{-9} Bq/cm^3) in Japan.

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Geochemical Environment and its Influence on Trace Element Content of Human Hair

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Evidences that geochemical environment can influence the elemental composition of the human hair have been searched for on the croatian island Krk in the northern Adriatic sea. All of the the collected environmental samples (soil, water, plant material) and human hair were analysed for 14 chemical elements by using EDXRF as an analytical tool. The contour maps for elemental concentration levels were produced by kriging gridding method with a linear variogram. Altogether, some 2,200 hair samples have been collected simultaneously with the recording of the answers to the questionnaire. Concentrations of the twelve chemical elements and nine variables from the questionaire, i.e. age, sex, living place, transportation, medication, hair colour, hair type, type of shampoo used, hair treatment, were considered in the statistical analysis.

The results of canonical correlation analysis show that from the nine variables used the three of them (sex, hair colour and hair treatment) have the greatest influence on the elemental concentrations measured in the hair samples. Analysis of variance shows that elements Mg, S, Ca and Ni are strongly sex dependent. Female's hairs have 2-4 times greater concentrations of these elements compared to the male's hair. Concentrations of Mg, S, Ca and Cr were mostly dependent on hair colour in the both sexes. Mg and S content significantly increase with hair darkness, while concentrations of Ca and Cr decrease from the black to the blond hair. It was also found that hair treatment (dyeing, bleaching, and permanent waving) results in the significant increase of Ca, S and Zn content in the hair.

Concentrations maps for the chemical elements measured are also used in the evaluation of chemical elements transffer from soils to plants, and eventually through food chain to the inhabitants of the island. It has been demonstrated that some of deseases (i.e. goiter) can be related to the chemical composition of the soil. The influence of geochemical environment on the concentration levels of chemical elements in children's hair has been discussed in some datails.

Influence of Aerosol Concentration and Multivariate Data Processing on Indication of Radon Progeny Concentration in Air

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Indication of concentration of radon progeny gauge in air is sensitive to aerosol concentration. Minimum detectable concentration and accuracy of the measurement is determined by random errors of the gauge. Multivariate data processing can be used to decrease random errors.

To investigate influence of aerosol concentration on indication of radon progeny concentration in air, measurements of mining radiometer, operating on the principle of alpha radiation detection from radon progeny deposited on air filter, were carried out in radon chamber. Aerosol concentration and radon concentration in radon chamber were controlled and measurements of radon progeny concentration was measured by radon progeny monitor. Additionally count rate from the monitor detector originating from alpha activity deposited on air filter was measured in 1 min. intervals that were later used for three interval, and Principal Component Regression (PCR) data processing.

It was found that for aerosol concentration in air from 40 p/cm^3 to approx. 9 000 p/cm^3 indications of the radon progeny monitor depends considerably on aerosol concentration. Radon daughters concentration normalized to radon concentration against aerosol concentration varied from 0.3 - 0.9. In mines where the aerosol concentration generally is high, this phenomenon has a little effect on the indication of the radon progeny monitor, but is has to be taken into account where aerosol concentration is low. Comparison of random errors when measured signal of the monitor (count rate against time) was processed employing three interval method and PCR data processing shows that PCR ensures 2-3 times lower random error than three interval data processing.

Multivariate Techniques in Processing Data from Radiometric Experiments

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Whenever data from a radiometric experiment are collected in the spectral form their processing with multivariate techniques can provide more efficient extraction of the information contained in the spectra. Three techniques are considered:

- multivariate calibration using Principal Components (PCR), Partial Least Square Regressions (PLS) and Artificial Neural Networks (ANN)
- standardization of the spectra using Direct Standardization (DC) as well as Piece-wise Direct Standardization (PDS)
- smoothing of the collected spectra where autocorrelation method and bootstrap were used for the assessment of processed spectra.

Application of those techniques is illustrated on examples of analysis and coating thickness determination using low-resolution XRF and scattering of the gamma radiation methods.

It has been shown that data processing with considered techniques directly results in several advantages:

- helps to extract information in those cases when it is not sufficiently selective within the entire spectrum (e.g. peaks overlapping)
- allows to include into the calibration model systematic factors that influence the final results (non-linearity, interelement effects)
- can make provisions against long term drifts of the spectra and changes in their shape (spectra standardization)
- may diminish the measurement error due to reduction of the statistical fluctuations (smoothing).

$^{239+240}$Pu and ^{90}Sr Deposition Densities in undisturbed Surface Soil in Vietnam

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The distribution of cumulative deposition of ^{137}Cs in undisturbed surface soil was well investigated in Vietnam. However, this kind of study for $^{239+240}$Pu and ^{90}Sr is still not performed in the country. In this work the cumulative deposition densities of $^{239+240}$Pu and ^{90}Sr were measured and compared with that of ^{137}Cs.

$^{239+240}$Pu and ^{90}Sr as well as ^{137}Cs deposition densities in undisturbed surface soil are determined for 30 sites having different geographic and geoecological conditions such as rainfall, soil properties, latitude, etc. Soil samples were taken at two depths, from the surface to 10 cm, and from 10 to 20 cm using a cylindrical corer with inner diameter of 4.2 cm. Soil properties such as texture, content of total organic matter, humic, fulvic were analysed for each sample.

The samples were passed through a sieve with a mesh of <1 mm to remove coarse gravels and then calcinated. ^{137}Cs in samples was analysed on a gamma spectrometer equipped with HPGe detector. About 50 gam of the dry soil was chemically treated and dissolved Pu was purified then electrochemically deposited on a stainless steel disk. $^{239+240}$Pu was quantified on an alpha spectrometer equipped with PIPS detector. Another 500 gam of the sample was radiochemically treated and ^{90}Sr was collected with strontium nitrate carrier. ^{90}Sr in the samples was analysed through its daughter ^{90}Y on a low level beta counting system. Quality control for the analytical results has been performed using IAEA reference material (Soil 4/2000) and the deviation between experimentally obtained results and certified values are within ± 5 %.

It was revealed that the $^{239+240}$Pu, ^{90}Sr and ^{137}Cs depositions in undisturbed surface soil in this study vary within a range of 18-96 Bq/m^2, 171-1026 Bq/m^2, 243-2965 Bq/m^2, respectively. The ratios of $^{239+240}$Pu and ^{90}Sr deposition densities to that of ^{137}Cs vary from 0.02 to 0.22 and from 0.09 to 1.17, respectively.

Physico-Chemical Characterization of Radioactive Particles dispersed in Palomares (Spain) due to a Nuclear Accident

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The remainder radioactive contamination in SE Spain after the nuclear accident that took place in 1966 has been comprehensively studied. The isotopic relations of Pu and Am oxides obtained from statistically representative radiochemical analyses of soil samples, collected in contaminated areas, show a dispersion of the data, which suggests the existence of two contaminating sources of different materials.

The characteristics of the accident, as well as the data given by the autoradiographies obtained from different environmental matrix (soil and gasteropoda ashes), suggest that the contamination is in particulate form of varying sizes.

The study of these particles is of great importance for the estimation of the accessibility of the contamination since their degree of accessibility for their incorporation in vegetables and, consequently, in men, as the last receptor, will depend on their physical and chemical properties and on their evolution in the environment.

This work shows the results obtained by applying optical and electron microscopic techniques to several radioactive particles, whose sizes are approximately 100 microns, and have been isolated from the soil. The isotopic relations of Pu and Am are also given based on radiochemical determinations carried out on these particles.

Application of Nuclear and related Analytical Techniques in Biomonitoring

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The mechanisms in which biomonitors survive in an unfavourable environment, such as nuclear weapon testing and nuclear accidents, are still unknown. In order to reveal the nature of these mechanisms, we investigated the uptake of cesium-137 by biomonitor species (mosses, lichens and mushrooms) as well as localization and cellular distribution of this radionuclide in their tissues.

Three different nuclear and related analytical techniques were used: gamma spectrometry (HPGe, NaI detectors), X ray fluorescence spectrometry and energy dispersive X ray fluorescence spectrometry.

From the the obtained results it can be concluded that (i) radiocesium is found in both organic and inorganic molecules, (ii) it is present in all cellular compartments, but predominantly in membranes (iii) only part of its initial amount is exchangeable with homologous cations and (iv) there are species-dependent differences in its distribution. The experimental evidence obtained using combination of the mentioned techniques imply that transmembrane proteins serving as potassium channels may be cesium binding sites in investigated biomonitors.

In this study cesium compounds have not been fully characterized, but it was evident that cesium is not associated with essential biomacromolecules. This could be a reason for tolerance of biomonitor species towards long-term retention of radionuclides in their tissues.

For better understanding of mechanisms and ways in which some organisms act as biomonitors, it might be useful to combine some nuclear and non-nuclear analytical techniques.

Determination of Sedimentation Rates and Sediment Yields using Cs-137 and Pb-210 Indicators

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Measurements of Pb-210 and Cs-137 in soils and sediments using alpha and gamma spectrometry methods were done to estimate the sediment deposition rates for seven reservoirs in Lamdong province, South Vietnam. The average sedimentation rates vary from 0.8 $cm.yr^{-1}$ to 2.2 $cm.yr^{-1}$.

The Cs-137 fallout was used for identifying the dominant process of soil erosion in catchments. The mechanism of erosion in the seven watersheds is quite different. Even within one watershed, as in the case of Tuyenlam reservoir, the differences in magnitude and mechanism of erosion processes were revealed.

The average sediment yields, which were inferred from the mass of sediment in the reservoirs and catchment areas, range from 36 $t.km^{-2}.yr^{-1}$ to 760 $t.km^{-2}.yr^{-1}$. An empirical model was developed to relate the sediment yield to the characteristics of rainfall and watershed. The logarithmic sediment yield values were regressed against the logarithm of the mean annual rainfall, rainfall in the month with greatest precipitation, slope, slope length and catchment area. The regression model containing the rainfall in the month with greatest precipitation and slope could explain 82% of the variations in experimental sediment yields.

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Measurement Of Boron in Soil using Proton Induced Gamma Emission Method

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Depletion of soil nutrients and its adverse effect on the productivity of crops is a major concern in the world today. Micro-nutrient boron plays an important role in the increase of production of crops as well as amino acids, which control the protein contents of the crops. Optimum concentration of boron in soil is essential for the growth and production of crops such as rice, potato, oat, soya bean, tomato, etc. The analysis of boron in soil is important but the conventional methods are usually lengthy and complex and there is always a chance of losing the trace elements in the process. In the present study proton induced gamma emission (PIGE), a nuclear reaction based analytical technique, has been employed for measuring boron in soil samples.

The concentrations of boron in soil samples collected from different parts of Bangladesh have been determined by measuring the gamma ray yield from the PIGE reactions. Forty samples have been analysed and boron has been found in 25 samples with concentrations lying between the range of 19.9-153 mg/kg, having a mean of 52.73 mg/kg. The PIGE sensitivity of boron in soil sample has been found to be 5 mg/kg for 100 μC irradiation. Some of the soil samples that have been analysed using the PIGE methodology have also been analysed for comparison by NRA facilities at the Institute of Geological and Nuclear Sciences Ltd., Lower Hutt, New Zealand. The results of the two measurements agree within ±16%, which indicates that the PIGE technique is a reliable method for analysing boron in soil sample. The simplicity and minimal requirement for the sample preparation and the clear knowledge of interfering nuclear reactions make PIGE technique an attractive method for the analysis of boron in arable soil.

Evaluation of ^{99}Tc^{m}-UBI and ^{99}Tc^{m}-HYNIC-UBI as Potential Infection Imaging Radiopharmaceuticals

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As reported by Welling, et al.[1], UBI (a derivative of antimicrobial peptide ubiquicidin) labelled with thechnetium-99m discriminates between bacterial infections and sterile inflammatory processes. In this study we compare directly labelled UBI with a bifunctional chelator conjugated HYNIC-UBI, obtained in our laboratory by solid phase synthesis. Direct labelling of UBI was performed as follows: to 34 µg UBI, 4 µg Pyr-Sn and 40 µg KBH_4 the volume of 0.2 ml of sodium pertechnetate-^{99m}Tc solution (200MBq/ml) was added and the mixture incubated for 1h at room temperature. HYNIC-UBI was prepared in a dry kit form using stannous chloride as reducing agent. The labelling of kits was done in a similar way as the direct labelling method. Radiochemical purity of labelled peptides was tested by HPLC and TLC and was found to exceed 95%. The preparations were tested in vitro for serum stability and for binding to living bacteria (multidrug-resistant *Staphylococcus aureus*, MRSA). Also, the labelled peptides were injected into mice having an experimental infection with MRSA or heat-killed bacteria and scintigraphy was performed to study their accumulation in infected and inflammed tissues. ^{99m}Tc-UBI and ^{99m}Tc-HYNIC-UBI kits can be easily labelled with high yields. The preparations are stable in vitro and show similar binding to bacteria (30%). In animals infected with MRSA the target to non-target ratios of both tracers ranged between 3 to 4 and the accumulation was much lower in tissues injected with dead bacteria. ^{99m}Tc-UBI and ^{99m}Tc-HYNIC-UBI seem to be good candidates for infection imaging agents.

Transfer of Iodine Deposited onto the Chinese Cabbage

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Iodine is one of the important radionuclides those should be considered for an accidental radionuclide release from the nuclear facility. Even the radiological half life of iodine-131 is shorter than the others, its impact on the thyroid is crucial in the beginning stage of accidental release. European Community has conducted lots of experiments for iodine transfer from the air to plant or soil to plant, however it concerns mostly to the western foodstuffs. The Chinese cabbage that is one of the principal foodstuffs in northeastern countries is tested by iodine exposure. Iodine-125 of which radiological half life is 60 days was used to measure the concentration change. Experiments were carried out four times which have different exposure times. The iodine source was prepared by chemical reaction of NaI in order to avoid producing relatively large elemental iodine which might be generated by crystal evaporation. The deposition velocity was obtained from the integrated air concentration and surface concentration of Chinese cabbage. The biological half life implying the weathering effects was also calculated.

Key words: iodine-125, Chinese cabbage, deposition velocity, biological half life.

Determination of Chemical and Radionuclidc Impurities in ^{177}Lu used for Labelling of Radiopharmaceuticals

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The chemical impurities can compete with the radioisotope during the labelling of a suitable radiopharmaceutical, decreasing the efficiency of this process and hence become a decisive factor of their usefulness. The radionuclidic impurities constitute unnecessary burden for a patient. ^{177}Lu is a very attractive isotope for diagnostic and therapeutic applications. It can be produced in a nuclear reactor in a very broad range of the specific radioactivity depending on the kind of target material used. The target material can consist of natural and enriched lutetium or natural and enriched ytterbium. As a result, the final product can be in the activity range from a few tens of mCi per mg to a carrier-free material (110 Ci/mg). We describe an analytical procedure with the use of inductively coupled plasma optical emission spectrometry (ICP-OES). A commercial instrument adapted for analysis of radioactive solutions was used. The following elements were determined: Al, B, Ba, Ca, Cd, Cu, Fe, Hf, Ni, Pb, Zn. The ^{177}Lu containing samples after unloading from the reactor were dissolved in hydrochloric acid, evaporated to dryness and dissolved again in 0.01 M HCl. The aliquots containing an amount of lutetium ranging from 1 to 100 μg in 1 mL volume were used for analysis. It corresponded to activity of ^{177}Lu ranging from 5 to 100 mCi. The detection limits of the elements concerned were in the range from 1 to 100 ngmL^{-1}. The activity of ^{177}Lu and other radionuclides present was measured using a high-resolution gamma ray spectrometer. The expected impurities are: ^{177m}Lu and ^{175}Yb. The detailed studies concerning the radioactivity concentration of these two nuclides were carried out. The developed procedures are to be used for routine quality control of ^{177}Lu produced for use in a synthesis of radiopharmaceuticals.

Methods of Measurements of Activity and Radionuclide Purity in Radioisotope Centre POLATOM

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Products for medicine make up the most essential section in the Radioisotope Centre POLATOM. Among others we offer the radiopharmaceuticals for cancer therapy and diagnoses. Therefore, one of the important issues is to assure the appropriate quality of the manufacturing process. The main quality standards are defined by the European Pharmacopoeia and must be strictly obeyed by producers. This paper presents procedures and methods of the quality control applied in RC – POLATOM, which allow determining the radionuclide purity and activity. Methods used for the determination of radioactive concentration depend on the type of radionuclide and required precision of measurement. The most precise measurements are performed while using the absolute methods with the application of coincidence LSC techniques. This way the activity of standard solutions is determined. Radionuclide concentration and activity are measured by relative methods, e.g. X-γ, β-α spectrometry, scintillation's NaI(Tl) counters and ionization chambers. Radionuclide purity is defined here as the ratio of impurity activities sum to the activity of the main radionuclide. The determination of this parameter is required by the consumer of RC POLATOM products.

Application of ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry) in Analysis of Radioactive Preparations

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Analysis of radioactive preparations of chemical composition constitutes a complex issue, particularly in cases when the need to detect the chemical impurities affects the suitability of preparations for biochemical or medical purposes. So far the most common analytical technique is the emission spectrography with an alternating current spark or arc excitation.

This paper deals with the problem of ICP-based OES (Optical Emission Spectrometry) application to the determination of main components as well as chemical impurities present in radioactive preparations produced at the Radioisotope Centre POLATOM. A Perkin-Elmer OPTIMA 3300XL spectrometer was specially adapted to work with radioactive solutions.

The spectrometer has been calibrated for determination of calcium in $^{45}CaCl_2$, chromium in $Na_2{}^{51}CrO_4$ and $^{51}CrCl_3$, phosphorus in $H_3{}^{32}PO_4$ and copper in $^{64}CuCl_2$. The purpose of accurate determination of chemical concentration of these elements was the evaluation of the specific activity of radioactive preparations containing these elements.

The spectrometer was also calibrated for determination of chemical impurities in radioactive preparations such as: eluates obtained from $^{99}Mo/^{99m}Tc$ isotope generators, $Na^{131}I$, $^{64}CuCl_2$, $Na_2H^{32}PO_2$, $Na_2{}^{51}CrO_4$, $H_3{}^{32}PO_4$, $^{51}CrCl_3$, $^{89}SrCl_2$, $^{90}Sr(NO_3)_2$, $^{90}YCl_3$. It has been established that the ICP-OES technique can be successfully applied to the determination of chemical impurities as well as to the quantitative analysis at ppb levels.

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The new RIA Kit for the Determination of Progesterone in Cow's Milk

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The determination of progesterone concentration in whole and fat-free milk 19–24 days after conception enables to distinguish between fertile and non-fertile insemination, which constitutes a significant issue in cattle breeding.

The aim of the research was to prepare a simple and fast RIA test for the determination of progesterone in cow's milk.

The following materials and methods were used: the solid phase – tubes coated with specific polyclonal ani-progesterone antibody; the 3-carboxymenthyl oxime-progesterone derivative was activated and then conjugated with ^{125}I–histamine; the HPLC system with Lichrospher RP-18 column and 65% acetonitrile + 35% water as eluent was applied to purify the progesterone-3-CMO-histamine-^{125}I; the immunoreactive material eluted at Rf=11 min. was used as a tracer in the test; progesterone (Sigma) and selected fat-free cow's milk without progesterone (milk zero) were the matrix for standard curve preparation.

Results: the optimal assay procedure was as follows — standards, controls and fat-free milk samples of total volume 50 µl were pipetted into coated tubes followed by 500 µl of diluted tracer, incubated for 2 h at RT, decantated and counted. Assay range: 0-275 nmol progesterone /L. Sensitivity: <1 nmol/L. Validation of this RIA test in terms of specificity, accuracy (recovery), precision (within assay and between assay variations) was done.

The concentration of progesterone in milk samples from pregnant and not pregnant cows delivered by the Institute of Animal Breeding, Polish Academy of Science was determined with the new RIA test and the obtained results were highly consistent.

New, ready to use (one step) RIA test for the determination of progesterone in cow's milk was worked out and checked. It simplifies the whole procedure and reduces the costs. The work has been done under research project POL-11715 co-ordinated by the IAEA.

Neutron Activation Analysis at the Service of the Worker Health: Determination of Arsenic

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In general, exposures in the workplace are registered when the are diseases easily identified. The major problem is that the great part of workers is exposed to low levels of toxic chemicals, that can be lethal in a long period of time, due to chronic diseases. Aiming at giving support to Worker's Health Awareness Program of the Municipal Department of Health of Belo Horizonte, an assessment was done in three galvanizing factories by means of airborne particulate matter collected in air filters and hair and toenail as biomonitors. This industrial process was chosen to be studied since the majority of patients who look for medical assistance because of metal contamination are hired by the galvanising industry.

The arsenic was determined in all matrixes concerning factories where gold electrodeposition process was applied. It is because usually arsenic salts are added to gold bath to improve the metal covering.

This project was the first action in order to assess the arsenic concentration level. Studies concerning galvanizing process have usually been developed broaching many aspects, but so far none had pointed out the detection and measurement of other elements like As. The results surprised the health surveillance professionals, and alerted for the need of assessing the influence of a long-term exposure. The results will support the establishment of guidelines and data basis for the next occupational program for this specific workplace.

The instrumental neutron activation technique — a mix of k_0 and monostandard method — was applied, confirming to be a suitable technique on determination of several elements in diversified matrixes.

This work was related to the IAEA' s Co-ordinated Research Project "Assessment of levels and health effects of airborne particulate matter in mining, metal refining and metal working industries using nuclear and related analytical techniques", Research Contract BRA-9473.

Gammaspectrometric Determination of Depleted Uranium in Soil

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Three years of monitoring the content of natural radionuclides as well as radionuclides of artificial origin in all samples in the south part of the Republic of Serbia and Montenegro indicated that there was widespread, low-level contamination by depleted uranium at this region. High activity of depleted uranium was found in the soil samples taken at the points where the penetrators were found.

We used high resolution gamma spectrometry measurements, because of their simplicity and accuracy. Aims of the control were to asses the increase of radioactivity above the natural levels in the immediate and near vicinity of the bomb craters, to asses the corresponding effect of changed natural radioactivity on the health of the population living in these places and finding unexploded depleted uranium bullets.

The collected soil samples were cleaned of plants and stones, dried at 105ºC–110ºC till constant weight for 24–48 h. After this, the samples were ground, sieved, and measure in cylindrical geometry.

Gamma activity was determined by gamma spectrometry measurements using HP Ge detector (ORTEC), with relative efficiency of 25% and energy resolution of 1.85 keV (1332.5 keV ^{60}Co). The analyser system conducts a peak search, energy assignment, quantification and nuclide identification in acquired spectra. Time of measurement varied from 60000 s to 250000 s.

Depleted uranium was found in the soil samples from Vranje region and cape Arza (Montenegro). There are four fenced areas in Vranje region (Pljačkovica, Bratoselce, Borovac and Reljan) and one in the Montenegro (cape Arza) where we have found depleted uranium penetrators. The ^{238}U and ^{235}U specific activities and their isotopic composition correspond to depleted uranium (^{238}U/^{235}U ratio from 35 to 77).

Ra-226 and Ra-228 in bottled Mineral Waters in Germany

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Natural radioactivity in bottled mineral water is of particular interest in radiation protection since the consumption of these waters increases in Germany and a considerable contribution to the radiation exposure can result thereby. Because of their radiotoxicity the Ra-226 (member of the U-238 decay series, alpha emitter) and the Ra-228 (member of the Th-232 decay series, beta emitter) are of primary concern. The Federal Office for Radiation Protection (BfS) has performed an investigation programme for the mineral waters produced in Germany. The aim of the study was to ascertain the variation of the radionuclide concentrations and to estimate the resulting radiation exposure to individuals drinking mineral water.

Radium nuclides to be analysed were separated from 5 litre samples. Ra-226 was determined by the emanation technique. Both Ra-228 and Ac-227 were determined applying the extraction chromatography. Actinium was isolated using a specific resin for the Lanthanides (Ln-spec). The activity of Ac-228, a short lived daughter product of Ra-228, was measured in a low-background proportional counter for about 16 hours using time gates of one hour.

The Ra-226 concentrations ranged from 0.7 to 1690 $mBq\cdot l^{-1}$ with a geometric mean of 8.1 $mBq\cdot l^{-1}$, whereas the Ra-228 concentrations varied between 4.6 and 930 $mBq\cdot l^{-1}$ with a geometric mean of 7.4 $mBq\cdot l^{-1}$. The variability of the Ra-226 to Ra-228 concentration ratio (0.13–23) points out that there is no correlation between the concentrations of these two radium isotopes.

Consuming mineral water the effective doses for individuals of each age-group are predominantly (80 - 100%) caused by Ra-226 and Ra-228. If the consumption rate for drinking water is assumed for the consumption of mineral water too, the dose values calculated for the critical group (infants) exceed in numerous cases the reference level of 0.1 mSv/a recommended by the World Health Organization (WHO, 1993) for drinking water.

The Sensitivity of Neutron Methods for On-Stream Analysis of Solutions

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The activation analysis of substances in a continuous flow, being by an express method using short times of activation and measurement, is most favourable for determination of elements with high activation cross-sections and forming as a result of activation short-lived nuclides. It is necessary also to consider an output of gamma-quantum both beta-particles by decay and distinctions in registration efficiency of radiation of different energy. Hence, the elements (Sc, In, Eu, Rh, Mn, Dy, Hf, Sm, Ag, V, I, Br, Ho, Lu, Au, W, Se, Co, Cu etc.) are most suitable for the activation analysis in a flow of a solution.

For the activation analysis of solutions in a continuous flow are typical in general the same sources of errors, as for the analysis of separate samples. Many from these errors can be taken into account or are reduced by a choice of the appropriate conditions of measurement (for example, application recirculation of solutions, activation by neutrons of different energy, use of specific types detectors, for example, of the Cerenkov detector, etc.).

In some cases use of special modes of the analysis in a flow allows to determine the concentration of light elements, determination of which by other methods is impossible or is inconvenient (Li, F, Na as well as V, Se, I, In).

At a choice of analytical methods for the inspection of wastewaters in the industrial enterprises it is necessary to consider the opportunities given by the neutron activation analysis of a continuous flow of liquids.

XRF Analysers and their Application in Ecology, in Mining and Processing Industries

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Nuclear analytical methods have very wide possibilities. They make it possible to determine the content of practically all elements of the periodic table with concentrations from 0,001% and more.

Metods of preconcentration, developed recently, give possibilities to minimize detectable concentrations of toxic, heavy and precious metals up to 0,01 ppm, which makes XRF metods competitive with more sensitive analysers such as neutron activation devices.

More then 20 types of XRF analysers have been developed in VNIITFA. The following devices are being produced now:

- Multi-element analyser for laboratory analysis of liquid, solid and powder samples (РЛП-3)
- Analyser to determine the content of chemical elements in drinking, natural waters, sewage and atmospheric aerosols (РЛП-1-3)
- Portable analyser for quantitative analysis of ferrous and non-ferrous alloys (РЛП-3-02)
- Portable analyser for field analysis with non-destructive method (ПРАМ-1)
- Analysers to determine uranium in undeground waters (РКМ-ПВ)
- Installation for rapid multielement analysis of ore in dump trucks (РКЦ-1М)
- Installation for measuring the content of metals in the solid portion of pulp directly in process flows (РЦП-1).

The report contains technical characteristics of all the above devices and examples of their application.

Preliminary Clinical Evaluation of ^{99}Tc^{m}-HYNIC-EDDA-TATE in comparison to ^{111}In-OCTREOSCAN and ^{131}MIBG

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Various tumours overexpress somatostatin receptors and thus can be targeted by the somatostatin analogues, which, after radioactive labelling, could be used in oncological diagnostics. A multi-centre clinical investigation on ^{99}Tc^{m}-HYNIC-Octreotide is currently carried out. In this paper we present a novel radiopharmaceutical, HYNIC conjugated Tyr^{3}-Octreotate (HYNIC-TATE) which was synthesized in our laboratory by solid phase approach and then prepared in a dry kit form for labelling with technetium-99m using Tricine and EDDA as co-ligands. The new radiopharmaceutical was evaluated *in vitro* and *in vivo* in an animal model and its potential for receptor scintigraphy was documented. In the current patient study the diagnostic usefulness of this new radiopharmaceutical was tested for detection of tumours expressing somatostatin receptors and compared to the results obtained in ^{111}In-Octreoscan and ^{131}MIBG scintigraphy. ^{99m}Tc-HYNIC-TATE complex was obtained in a one step labelling procedure with the yield over 95%. Activities of 740 – 925 MBq of the radiotracer were administered i.v. Ten patients: 6 with suspected carcinoid, 2 with insulinoma with positive ^{111}In-Octreoscan scan, 1 with medullary ca and 1 with pheochromocytoma with positive ^{131}I-MIBG scintigraphy. Scintigraphic imaging was carried out (whole body and/or SPECT) 10 min, 4 and 24 h p.i. using dual head large field of view Siemens camera with medium energy collimators. High quality scintigraphic images were obtained; maximal tumour activity accumulation was reached about 4 h p.i. The results of ^{99}Tc^{m}-HYNIC-TATE scintigraphy were comparable to those of ^{111}In-Octreoscan and ^{131}I-MIBG scans. ^{99}Tc^{m}-HYNIC-TATE scintigraphy is a useful tool in detection of tumours expressing somatostatin receptors, better tumour to non-tumour contrasts are obtained compared to SRS (^{111}In-Octreoscan and ^{131}I-MIBG) in same cases.

Use of Geostatistical Analysis in Radon Mapping

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Radon entry from the soil into the buildings is considered to be a major source of indoor radon. Monitoring of the volume activity of ^{222}Rn in the soil air is complicated because of its unstable nature in the time and space dimension. Radon concentration is influenced especially by the geophysical parameters of the soil, bedrock and weather conditions such as atmospheric pressure, temperature and wind velocity. Mapping, surveying, analysing and interpreting radon field spatio-temporal structure is important from the point of view of human health protection, landscape planning and revealing specific spatio-temporal behaviour of this phenomenon.

This contribution is focused on the radon field modelling in its spatio-temporal dimension on the basis of long term monitoring by means of geostastics tools. In the first part is discussed the structure of proposed sampling scheme with respect to the geological structure and other related factors. The second part is focused on the evaluation of autocorrelation parameters and anisotropy axes ratio. Furthermore, by means of chosen estimation procedures is evaluated continuous radon field with respect to *a priori* information of the main geological gaps courses. In the third part quality and accuracy of the proposed continuous radon field are assessed. Temporal aspect was investigated with the help of Time Series Analyses procedures in the GIS environment. Some aspects of uncertainties of standard method for radon risk classification used in the Slovak Republic are discussed, too. In this point fuzzy sets theory was involved.

Quality Control of INAA-k_0 and ICP-MS as Bio-Monitoring Analysis Techniques — Application to Moroccan Atmospheric Pollution Study

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Many studies have been conducted to study atmospheric pollution using different techniques to determine the quality and quantity of pollutant elements. Those techniques differ in their capability of analysing as large spectrum of elements as possible, their sensibility to the presence of trace elements and their accuracy.

In this study the interest turns on the INAA-k_0 and ICP-MS techniques due to their adequate characteristics to analyse accurately a wide number of elements interesting the bio-monitoring.

To check the measurement reliability and accuracy of those two techniques, we have analysed samples of reference materials and compared analysis results of divers elements in lichens, mosses and tree barks.

The results given by reference materials analysis and bio-monitor comparisons let us conclude that INAA-k_0 and ICP-MS are very suitable for the bio-monitoring task, complementary and they can be substituted for analysis of the majority of elements.

An XRF Study on the Pigments in Wood Carving of Jesuit Missions of Argentina

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The Jesuit organization in South America included Missions where doctrinal and cultural activities were done in order to civilize the native population. A series of Jesuitical ranches were built in the territories where the missions were located to complete the economical development of the Jesuit organization. There was no pomposity in the architectonic project of these farms because they used only local materials (rolling stones, algarroba wood, clay bricks and roof tile, lime, gypsum, melted metals, etc.). This work describes the use of X ray Fluorescence Spectrometry to study colonial Jesuitical art from the XVII century. A series of wooden painted carvings was analysed at CEPROCOR using a portable energy dispersive X ray fluorescence spectrometer. These pieces belong to the Jesuit missions placed in the centre or Argentina, recently categorized as cultural heritage of humanity. Pink and blue pigments of the smalt were studied because these colours are unexpected in colonial Jesuit art. The binder of enamel taking from the pieces where it was allowed to scrape was studied by IR spectroscopy. The thin gold layer was also studied, usually used in Jesuitical art to cover the wooden religious objects.

This work is the beginning of a series of studies of Jesuit art pieces included in a restoration programme. The pieces analysed were chosen because the suspicions of restorers of an alteration in the colours of some parts of “La Candelaria” altar. The Jesuits did not use the present colours observed in the carving. This is confirmed by the presence of Zn in blue, pink and white smalt, because the presence of ZnO pigment in the composition of smalt is later attributed to expulsion. This fact confirms the alteration of carving after the 3rd decade of century XIX. XRF studies do not reveal Au pigments in the layers conforming to the substrates of the smalt.

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An Application of the X ray Fluorescence and Multivariate Analysis for the Study of the 18th Century Vessels from Lubaczow Glasshouse

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Provenance and dating problems constitute one of the most important challenges in the study of Baroque glass. The X ray fluorescence and multivariate analysis was applied for identification and dating of vessel glass originated from Polish glasshouse in Lubaczow. The 18th century Lubaczow glass from different periods was defined on the basis of differentiating the raw materials sources and the technology applied. The links between the stylistic featuring and chemical characterisation of glass vessels were found. A subset of variables that best discriminate between the groups were identified by application of the discriminant analysis method. The classification functions for allocating the new unclassified objects to the recognized groups were calculaded. The obtained results show that the statistical tools are very useful and complementary to the stylistic studies of historical objects.

Precise Uranium Isotopic Measurements in Groundwater around the CEA's Vaujours Site

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In the framework of French nuclear weapons development programme, the test site of Vaujours (localized in Seine Saint-Denis, France) has undergone a large number of explosive experiments involving materials including uranium containing devices.

The problem of contamination in the environment by uranium around this non-nuclear facility has become extremely sensitive when CEA (the French Atomic Energy Commission) decided on the decommissioning and renunciation of the site.

A large number of samples was taken in 2001–2002 in and nearby the site of Vaujours. Low level γ spectrometry as well as mass spectrometric techniques (TIMS and ICPMS) were used to measure hundreds of soil, core, lichen, moss and groundwater samples to assess the impact of the activities on the environment.

Since natural uranium is present at ppm levels in soils and at ppb levels in water, we used high precise thermal ionization procedures to screen for any anthropogenic components.

The aim of this paper is to make the demonstration of the effectiveness of the so-called resin bead technique to load (sub-)nanogram amount of uranium on TIMS filaments, under clean laboratory conditions. We could achieve a precision around .2% (RSD) for 235/238 ratio with a double focusing VG54-38 instrument in a laboratory built pulse-counting mode. The minor isotopes were also measured and some 234 data will be discussed in the poster. Natural and depleted standards were used to correct for mass fractionation, and no double spike was used.

IAEA-CN-103/090P

Distribution of Gamma Emitter Radionuclides in Coastal Sediments near the Venezuelan Atlantic Front

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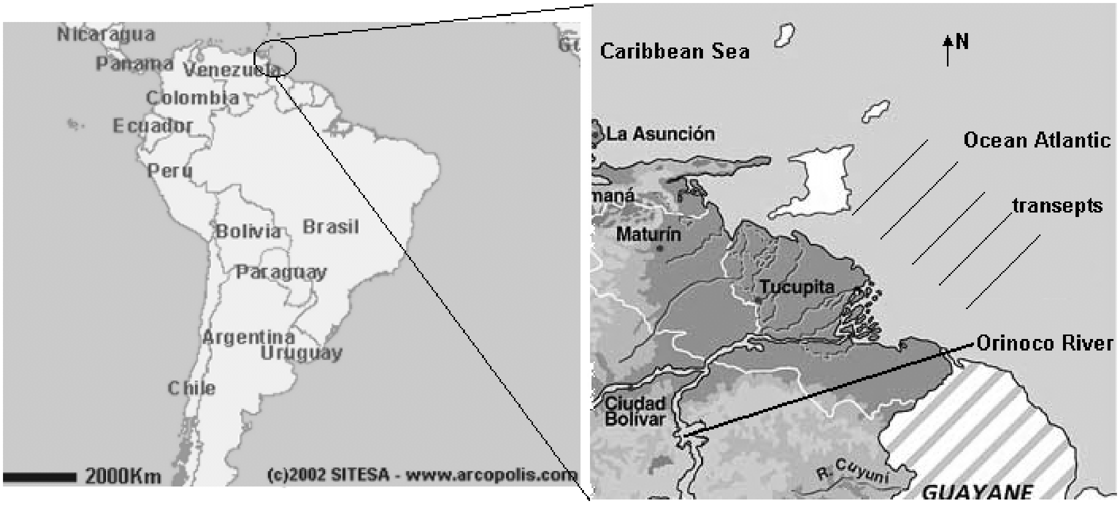
An aspect of interest in studies about river deltas is the origin or source of marine sediments. Natural erosion and human activities can condition particular radionuclide redistribution and accumulation in marine sediments when radioactive elements are transported fundamentally from earth to sea through rivers and atmosphere. The differentiated accumulation of radioactive elements in marine sediments can be the result of its transport from near areas. In this work the concentration of natural and antropogenic radioactive elements in superficial samples of marine sediments are presented. The samples were collected near the Venezuelan Atlantic Front coast, where the influence of the Orinoco and Amazons rivers should be reflected due to the Northeast direction of marine currents (see figure). Surface samples (from depth up to 20 cm) of sediments from 50 stations distributed in the study area (along five transepts perpendicular to the coast), were recollected and measured by high resolution gamma spectroscopy using a HpGe detector of approximately 2 KeV resolution for the 1,33 MeV ^{60}Co peak and efficiency higher than 20% (supplied under the IAEA Technical Co-operation Project VEN-9-005). In order to determine correlations between the different radionuclide concentrations and carry out inferences on the causes of founded distributions, different statistical procedures were applied. This coastal sediment characterization of the Venezuelan Atlantic Front allowed us to obtain a map of radionuclide concentrations in this area, which will serve as reference for future investigations. IAEA Analytical Quality Control Services supplied reference sample for this study.



IAEA-CN-103/093P

Gamma Radioactivity in Sediments of Maracaibo Lake, Venezuela

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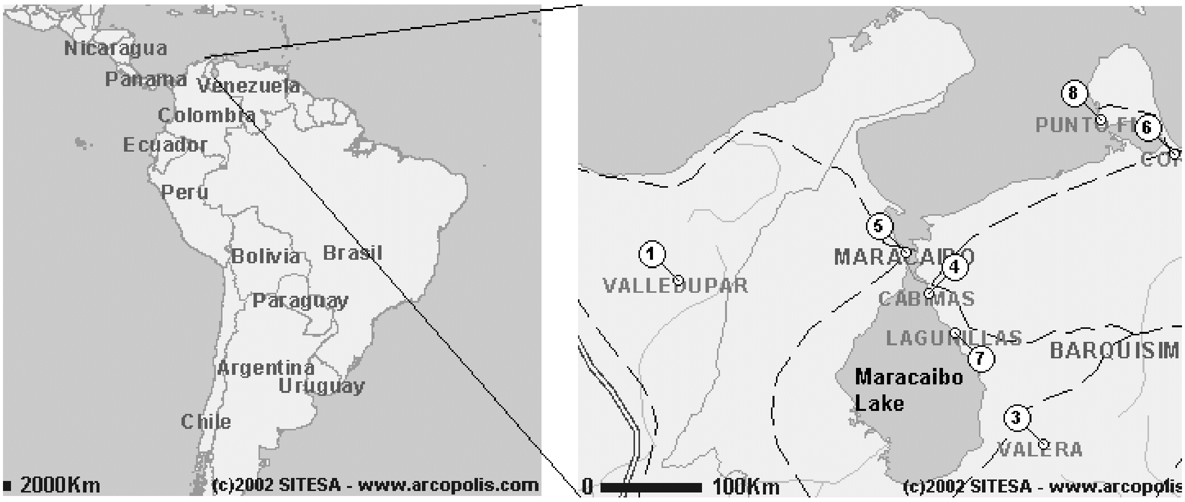
Maracaibo Lake is located to the west part of Venezuela (see Figure), with a surface of 13.000 Km^2, its coast embraces a longitude of 729 Km. This lake is the largest fresh water hydrologic basin of Venezuela and its ecosystem is subjected to intense and constant modification due to the strong oil exploitation developed in this region. Both in the coastal area and inside the lake, the petroleum extraction process induces modification in the ecosystem. Radioactive content characterization was carried out in coastal sediments of Maracaibo Lake, measuring the specific activity of the following elements: ^{40}K, gamma emitters of the natural radioactive series (^{238}U and ^{232}Th) and radioactive elements of antropogenic origin (^{137}Cs, among others) and cosmogenic as Berilium-7. The radioactive disequilibrium in the ^{238}U and ^{232}Th series was evaluated. Surface samples (from depth up to 5 cm) of the sediments along the coast were recollected and measured by high resolution gamma spectroscopy using a HpGe detector of approximately 2 KeV resolution for the 1,33 MeV ^{60}Co peak and efficiency higher than 20% (supplied under the IAEA Technical Co-operation Project VEN/9/005). The ^{137}Cs concentrations ranged in the interval 0,5–13,1 Bq/kg, while those of natural radionuclides are ^{238}U (2,12 - 5,01 ppm), ^{232}Th (6,71–38,58 ppm) and ^{40}K (1,05–3,64%), assuming radioactive equilibrium in samples. Between elements of the ^{238}U series high correlation was obtained while it is low between those of the ^{232}Th series, being evidenced radioactive disequilibrium in this series. We found high positive correlation between ^{40}K and elements of the ^{232}Th series, and in turn low and negative with those of the ^{238}U series. ^{232}Th and ^{238}U correlate negatively one to each other. This coastal sediment characterization of Maracaibo Lake allowed us to obtain a map of radioactive levels in these areas, which will serve as reference for future investigations. Reference sample for this study were supplied by IAEA Analytical Quality Control Services.



Determination of Atmospheric Concentration of Toxic Metals along Urban Motorways in two Nigerian Cities using TXRF Technique

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Pollutants due to vehicular emission is a major source of human health deterioration in many countries. This is especially so in Nigeria where substantial number of old vehicles, which no longer meet environmental standards set in developed countries, are being imported. In an urban city like Lagos, hundreds of thousands of hawkers that spend the whole day along motorways are victims of pollution from vehicular emission.

Ambient air along major motorways in an urban setting in Lagos and Ile Ife in southwest Nigeria was sample for eight hours at each location selected. Locations were selected to reflect variations in traffic volume and corresponding number of those exposed. Sampling was done using both a twin-flow air sampler for total suspended particulate matter and a stacked “Gent” PM_{10} sampler to determine the inhalable fraction. Volume of traffic at each location was also measured. Whatman 41 filters used for the TSPM and Nuclepore filters used for the PM_{10} samplers were digested using ultra-pure acids and then analysed using a total reflection X ray fluorescence spectrometer donated by the IAEA. Ga was used as internal standard.

Concentrations of the pollutants were determined using the QXAS software. Source apportionment was carried out to determine the contribution to the pollutants from vehicular emission.

Sequential Leaching Extraction of ^{239,240}Pu, ^{238}Pu, ^{241}Pu and ^{241}Am from a Mud Sample: An Intercomparison Study

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The determination of the association percentages of transuranics to different sediment phases could define their fate once they have been deposited onto the marine floor and their possible reactivity at the sediment/sea water interphase.

Nowadays, there is a wide variety of leaching methods to extract transuranics from the different geochemical compounds conforming the sediments. Nevertheless, a general controversy is extended in the scientific world due to the extreme difficulty in testing their reliability, since the standards of transuranics linked to a certain sedimentary phase are not commercialy available.

Two mud subsamples taken from a storage container were analysed employing the same sequential extraction method, but with small handling differences.The following fractions were isolated: (1) Readily avalaible (2) Carbonate bound and specifically adsorbed (3) Organically bound (4) Oxide and hydroxides bound and (5) residual. The ^{239,240}Pu, ^{238}Pu and ^{241}Am extracted in each phase were analysed using standard radiochemical procedures. ^{241}Pu was determined by both direct scintillation counting and through the ^{241}Am in-growth up on the old disks containing Plutonium. The procedure for uncertainty calculations has been also included.

IAEA-CN-103/104P

Prompt Gamma Neutron Activation Analysis of Boron in Samples by using an Am-α-Be Isotopic Neutron Source

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Boron with high neutron capture cross-section does not give any delayed γ ray with a convenient half-life after neutron irradiation. Therefore, of particular importance for prompt gamma ray activation analysis (PGAA) technique has been the measurement of boron by detecting the Doppler-broadened 478 keV gamma ray from the reaction $^{10}B(n,\alpha)^{7}Li^{*}$. Boron measurements were carried out by an experimental set-up consisting of a 22.6%REGe detector and a 740 GBq Am-α-Be neutron source moderated with water and paraffin. In the PGAA set-up, the Cd ratio for gold monitor was measured to be 22 at the sample irradiation position and the corresponding thermal neutron fluence rate was 3×10^{4} $n.cm^{-2}.s^{-1}$. The most important drawback of the present PGAA technique is the high level of γ ray background arising from various origins. The main ones are the γ rays from the source itself, e.g. 59.6 keV (35.9%) and other 162 γ rays with weak intensities emitted from ^{241}Am nuclide. To remove these γ rays from the background, the Am-α-Be neutron source was surrounded concentrically by lead rings. The 2.223 MeV (100%) γ ray from $^{1}H(n,\gamma)^{2}H$ in moderator and the 4.43 MeV (0.6γ/n) γ-ray from the first excited state of $^{9}Be(\alpha,n)^{12}C^{*}$ in the source and, together with their single and double escape peaks, have been reduced substantially at the detector side by additional shielding. The detector were also shielded against neutrons by a 1 mm thick Cd case, a 5 cm thick cap containing Li_2CO_3 powder.

The absolute detection efficiency in the energy range of 60-2000 keV was determined using multinuclide standard solution and powder. 95% ^{10}B-enriched boric acid (SRM 952), boron standard solution (SRM 3107) and borate ore (SRM 1835) obtained from NIST were used calibration measurements. The sensitivity and detection limit were obtained for boron in such a PGAA irradiation set-up. Then, an application to determination of boron content in boric acid samples prepared from Turkish borate ores.

Measurement of Nitrogen in Explosives using Nuclear Techniques

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Detection of anti-personnel mines and other types of explosives has been investigated by measuring the nitrogen contents of these materials. Explosive materials have nitrogen content of between about 15 to 46%. The technique employs a ^{252}Cf spontaneous fission neutron source. Prompt gamma rays emitted by nitrogen followed by capturing neutron are detected by three 3”×3” and one 5”×5” NaI(Tl) detectors. The detection system was calibrated using nine standard nitrogenous materials supplied by Merck. The standard materials contained 12.27-46.63% nitrogen. Each standard material was irradiated for about 600 seconds. Samples with unknown quantities of nitrogen were irradiated under similar experimental conditions.

10.8 MeV gamma rays and the escape peaks were detected. Nitrogen contents of samples were measured using calibration data curve. The results were compared with that of chemical analysis (Kjedalhl’s Method). A good agreement was observed between results using chemical techniques and that of nuclear technique.

It is experimentally shown that nitrogen content of 10 grams in sample could reliably be measured with a statistical error less than 20%. Measurements were repeated using three BGO detectors. The size of BGO detectors was 3”×3”. The efficiency of BGO detectors for 10.8 MeV gamma rays is considerably higher than that of NaI(Tl) detectors, which results in higher accuracy the data. Obviously if higher neutron flux is employed (e.g. by using the existing neutron generator) that could increase the accuracy of measurement over further.

An Overview of Indoor Radon Study carried out in Dwellings of India and Bangladesh During the Last Decade (1990-2000)

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There is an increasing concern about exposure to radon and its progenies due to their detrimental effects on the health of inhabitants. It is very clearly stated in the reports of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) that out of 98% of the average radiation dose received by man from natural sources 52% is due to breathing of radon and progenies present in the dwellings. Large scale surveys have been carried out in developed countries but relatively few surveys have been reported from developing countries like India and Bangladesh where such a study becomes more important due to their high population density.

In the proposed presentation the experimental data collected by various research groups from nearly 50 different locations in India and Bangladesh including the work from Khubavali in Pune will be presented. These data have been obtained using the passive detector technique. In this method the tracks developed in LR-115 (Type II) or CR-39 solid state nuclear track detectors as a result of exposure to indoor radon and its progenies is measured after suitable chemical treatment using a spark counter or an optical microscope. The calibration of the detectors was carried out in the calibration facility of the Environmental Assessment Division of Bhabha Atomic Research Centre, Mumbai.

The national geometric mean value of the indoor radon concentration based on the available data is obtained as 67.1 Bq m^{-3}. The lowest indoor radon concentration of 27.3 Bq m^{-3} was obtained in Chuadanga in the Bangladesh and the highest amounting to 281.5 Bq m^{-3} was found in Una in the northern part of India. The geometrical mean results will be discussed in terms of the national average of other countries as well as in terms of geological influence and will also be compared with the indoor radon levels prescribed by the International Commission on Radiation Protection.

Radionuclide Analysis by Gamma-Ray Spectrograms of Environmental Samples

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Radionuclide analysis of environmental samples are carried out at laboratory gamma-spectrometric device SARI-2 (system of radiometric measurements automation) that consists of standard blocks — the analyser of impulses AI-1024, stintsilational gauge NaJ (Tl) type 6931-20 (size of crystal 150×100, FEU-49), blocks of power such as BNVZ-05, BPZ-591. The detector is protected from natural radiation by a special leaden small house, with thickness of walls 100 mm and with a three-layer facing of Cd-Cu-Al.

Using this device nuclear composition in various liquid and solid objects has been studying in Azerbaijan. The nature of radioactive anomalies at the fields contaminated by oil and their uranium-radium origin were revealed. Radionuclide composition of water from surface and underground channels within oil fields territories and samples from different industrial sites were also investigated.

Analysing building materials (bricks, suspended ceilings, etc.) high level of radium in some of them was determined. Presence of Cesium-137 in several food products was established.

More over increment of natural radioactive background in Maycopian rocks (Oligocene-Miocene) associated with the presence of great amount of elements of uranium-radium series.

So the radionuclides anomalies nature, elements content and relation to different technogenical and geological processes were revealed.

Newer Trace Elements Measured by RNAA and AAS

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Very recently, quite attention has been made on a few more trace element in foodstuff as newer essential for animal and human health in certain ranges of concentration or intakes. These traces are, namely: aluminum, nickel, vanadium and tin. Al and Ni have been measured by atomic absorption spectroscopy (AAS), and two latter ones measured by radiochemical neutron activation analysis (RNAA) in few references laboratories. These measurements were made for the most of the Iranian diets and other participant countries' diets under the framework of a co-ordinated research project (CRP) of the International Atomic Energy Agency (IAEA) during the period of 1986–1994, but practically it took more years. Here in this work the daily dietary intakes of above mentioned trace elements are given and discussed while the results of other 20 more nutritionally important trace elements appeared somewhere else.

Se and I Content in Military Total Diet

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Selenium and iodine are trace elements that play important role in health of man and animals. Concerning supply of both elements it is important to meet nutritional needs. According to discoveries selenium is a part of an active group of glutathione peroxidase enzymes. It prevents necrotic changes in liver, muscle dystrophy and has impact on growth. Extensive studies on content of selenium in plant and animal origin products were started in the beginning of the seventies in Western Europe [1]. The aim of our work was to determine selenium and iodine content in total diets of Slovene military. Slovene military nutrition is based on its own nutritional standards, which determine 200 µg of iodine and 50 µg of selenium in daily diet [2].

To determine if the amounts of both elements meet the standards we have analysed 20 total daily diets from four different barracks within a two-month period. Selenium and iodine in freeze dried samples were determined by radiochemical neutron activation analysis. It was estimated that the average daily intake was 460±126 µg of iodine and 90±33 µg of selenium. Both results meet the recommended military nutritional standards [2].

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Behaviour of Radioactive Cesium in Northern Boreal Forest Ecosystems

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In 1997–2001 a large number of environmental samples have been collected from the Muddusjärvi area in Finnish Lappland. These samples include soil, water, sediment, vegetation and fish samples. Radioactive contamination in this subarctic environment has mainly resulted from the nuclear weapons test fallout in the 1950s and 1960s. Chernobyl accident did not considerably increase the contamination level in this area. The Laboratory of Radiochemistry, University of Helsinki, has been studying the behaviour of fallout radionuclides in the environment and in food chains in Lappland from the beginning of the 1960s. The study area lies in the middle of northern raindeer hearding area where accumulation of radioactive cesium has been observed in food chains.

In this paper we report on the behaviour of radioactive cesium in soil columns. The soil in this area is typically nutrient-poor podzolic soil. Altogether thirty soil columns were collected and they were devided into horizons (litter, organic and mineral layers). The activity concentrations of the horizons were determined by gamma spectrometry. In general, cesium has been concentrated mainly in the litter and organic layers and it has not been migrated considerably to mineral layers. To study the long term behaviour of cesium in soil the activity concentrations have been compared to those found in earlier decades and to the activity concentrations earlier determined for other radionuclides, especially for Pu. A further major objective was to study runoff of radionuclides from ground to lakes and brooks and therefore many of the soil samples were collected from various distances from lakes and brooks.

Carbon Sequestration and estimated Carbon Credit Values as measured using ^{13}C Labeling and Analysis by an Optical Breath Test Analyser

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Recent developments in optical systems for breath testing have provided a robust, low-cost option for undertaking ^{13}C analysis. Although these systems were initially developed for breath testing for *Helicobacter pylori*, they have an enormous potential as a soil science research tool. The relatively low cost of the equipment at US$ 15000–25000 is within the research budgets of most institutes or universities. The simplicity of the mechanisms and optical nature mean that the equipment requires relatively low maintenance and minimal training.

Thus methods were developed to prepare soil and plant materials for analysis using the breath test analyser. Results that compare the conventional mass spectrometry methods with the breath test analyser will be presented.

In combination with simple ^{13}C-plant-labeling techniques it is possible to devise methods for estimating carbon sequestration under different agronomic management practices within a short time frame. This allows an assessment of the carbon credit value of a particular agronomic practice, which can in turn be used by policy makers for decision-making purposes.

For a global understanding of the effect of agricultural practices on the carbon cycle data is required from a range of cropping systems and agro-ecological zones. The method and the approach described will allow collection of hard data within a reasonable time frame.

Keywords: Organic matter, stable isotopes, FANci2

The Tranfer of Radiocesium from Fallout and Artificially Contaminated Soil to Tea and Black Cabbage Leaves

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The uptake of radionuclides by plants is an important pathway in the transfer of the radionuclides to man. Radionuclides can be incorporated by uptake from the soil via roots. This pathway is often the most significant for calculation of exposed doses. In general assessments, the quantity of radionuclides accumulated from soil to plant is determined with a transfer factor (TF). The aim of the study was to determine the TF values of ^{137}Cs radionuclide from soil to tea leaves by Chernobyl and artificially contaminated soils in the experimental nursery area of Rize town in eastern Black Sea region of Turkey. At the same time, the TF values of ^{137}Cs in black cabbage leaves were also calculated in artificially contaminated soil types and under Chernobil contaminated conditions. The transfer factors of ^{137}Cs for tea leaves in old plants in Chernobyl contaminated soils ranged from 0.079 to 0.890. In another field experiment, the mean transfer factor of ^{137}Cs was found to be 0.051 in tea leaves of young plants which was planted in Chernobyl contaminated soil. On the other hand, this mean ratio is calculated to be 0.169 in tea leaves of similar planted plants in same Chernobyl contaminated soil which was also contaminated by additional ^{137}Cs.The TF value of ^{137}Cs radionuclide of the black cabbage in flooded soil is slightly higher than those obtained in local and sheltered local soil samples. The mean TF value of ^{137}Cs for black cabbage samples was calculated to be 0.009 and ranged from 0.004 to 0.018. On the other hand, the TF values in the black cabbage leaves under Chernobyl contaminated area are found significantly high levels than artificially contaminated the field experiments. The mean TF values of the radionuclide were determined to be 0.356 and 0.360 in 2001 and 2002 samples. From data obtained with tea and black cabbage leaves, it is difficult to compare the results in artificially field and Chernobil contaminated conditions. For this reason, the determination of stable cesium concentrations in soil samples may be used further developments beside of the other parameters.

Leaching of Radioactive Isotopes from Ash

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The aim of the study is to reduce the environmental impact of ash deposits. Ash from coal and biomass combustion, containing uranium and thorium from Yatagan-Silopi and Tuncbilek coal; cesium-137 from forests in northeastern Turkey and central Sweden. Turkey is dependent on coal for power generation and huge volumes of ash (>15 Mton/yr) are produced every year. Because of that certain coals, in particular Yatagan, with known problems from Mo and U leaching to the ground water, and Silopi oil shales/asphaltites were studied. Biomass ash comes from branches, bark and other unused parts of the trees and plants. This ash has low concentration of environmentally hazardous metals, but ^{137}Cs is a problem in certain regions and it is of interest to investigate the possibilities to leach this metal from the ash. Washing ash through rapid chemical leaching at low pH reduces the slow release of metals from ash due to precipitation and besides it may lead to metal recovery from the ash. Initial experiments were done in batch form, in which the neutralizing capacity at pH 1-1.5 was measured by adding sulfuric acid to maintain pH for mixtures of ash and water. Subsequent experiments were done in bench scale. The process also reduced the metal content of the ash, due to chemical leaching of metal oxides and ion exchange at the surfaces of stable oxides. This means that treated ash will not release further metals and, eventually, relaxes the requirements on depositories and allows the ash from coal to be used as an admixture in cement, and to be used as a fertilizer following aftertreatment of ash from biomass.

Risk assessment of Radon Exposures in Zonguldak Bituminous Coal Basin in Turkey

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Radon and its short-lived decay products in the atmosphere are the most important contributors to human exposure from natural sources. The health risks associated with high radon exposures in underground mines have been known for a long time. In this study, radon concentration measurements have been carried out in Kozlu, Karadon and Üzülmez underground mines in Zonguldak bituminous coal basin in Turkey. Passive time integrating method, which is one of the most important techniques for the measurement of radon concentration in air, was applied and Nuclear Track Etch detectors were used for radon measurements. Influences of the depth and ventilation rates were investigated. The annual effective doses and lifetime risks from chronic occupational exposure of the workers were calculated. Radon concentrations were varied from 253 to 1470 Bq m^{-3} in the mines. The calculated annual effective doses and the exposure doses were found from 4.72 to 5.08 mSv and from 0.32 to 1.85 WLM, respectively.

Biomonitoring Air Pollution in Chile

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Chile, in general, and Santiago, its capital city, in particular, has serious air pollution problems mainly in winter time when the pollutants could reach dangerous levels which might be detrimental to older people and children.

A project was undertaken within the framework of a Co-ordinated Research Programme (CRP) supported by the International Atomic Energy Agency (IAEA) to carry out a long term study on atmospheric air pollution in Chile using biomonitors. The present paper describes the activities carried out within this CRP.

The lichens, collected in clean areas (native forests), were transplanted to selected sites in Santiago and exposed during three and six months. At a second stage, samples of *Tillandsia recurvata* were collected in the Metropolitan Area. All samples were carefully cleaned, using only clean plastic materials, milled at liquid nitrogen temperature, freeze dried, re-homogenized and stored at low temperature until analysis. The samples were mainly analysed by INAA, RNAA SS-AAS and ASV. As part of the routine QA/QC programme, analytical laboratories involved in the project participated in intercomparison runs organized by the IAEA for the determination of trace and minor elements in two lichens samples.

From the data and its subsequent mapping over the area under study, it was possible to identify places exposed to higher amounts of some elements. Of interest are also the correlations between several elements, perhaps indicating a given source of pollutants. The results indicate the usefulness of biomonitoring air pollution using lichens and *Tillandsias,* which, jointly with multielemental analytical techniques, such as NAA, open the possibility to study extensive areas without the infraestructure needed for conventional APM sample collection and at reduced costs.

Deposits Monitoring and Health Consequences in Tien-Shan

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There are nature uranium geo-anomaly (100 times higher compared with European soil); after-effects of the USSR uranium-factories (working in 1950-1988); landslides, earthquakes dangers, groundwater peculiarities — the presence of all complicated the radioactive danger in the Tien-Shan region. We have made ranking of the territory by eco-catstrofes danger level, each of factors separately, and by common cummulative consequences of the factors. Secondly, we have made ranking of the territory by human ecology position, and here we include biogeochemistry disturbances and hypoxia level. We studied several mountain-isolated Asian populations according to the above mentioned ranking of the territory. Uranium deposits have been chosen as target areas (with water and soil level monitoring) and their biological peculiarities were studied (flowers mutation, human immunity and biomembranes peculiarities). We try to find any correlation among environment radioactivity, isotope bio-deposition (which includes isotopes in teeth) in one hand, and bio/health tests in the other hand. Blood samples were taken from the groups of aboriginal population. Erythrocite membranes were examined, immunity tests (first and second levels) were done simultaneously. Gas-liquid chromatography and electromagnite-resonance have been used. We may conclude that same markers will be sensitive and earlier indicators of complex radionuclide-chemical pollution.

Monitoring and Evaluating Efficacy and Effectivenss of Fortified Food-based Interventions using Isotopic and Nuclear Techniques

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It is recognized that both supplementation and food fortification are effective means to correct nutritional deficiency of micronutrients particularly Fe depending upon the field conditions faced. Although significant progress seems to have been made to identify useful fortificants, the final outcome is dependent upon the type of supplement or fortificant used and the interactions between the nutrients involved as well as cost-effectiveness including the potential to reach large number of people. For many years now, the International Atomic Energy Agency's (IAEA) activities in the human nutrition area have demonstrated the usefulness of nuclear and related isotopic techniques as tools in support of nutritional studies related to micronutrient malnutrition.

In dealing with alleviation of nutritional deficiency of Fe, a major concern is the bioavailability of Fe from foods and the method based on administering stable isotopes (isotope ^{57}Fe or ^{58}Fe administered to the subjects through a test meal that is extrinsically labelled) is the only reliable way of measuring the uptake of iron. Since the newly absorbed iron is primarily used for haemoglobin synthesis, iron bioavailability from a specific diet can be determined by measuring the incorporation of an iron isotope into red blood cell haemoglobin 14 days after the ingestion of the test meal. The method is even applicable to pregnant mothers and children. Isotopic techniques have also proven to be very effective in evaluating and monitoring (efficacy and effectiveness of various fortificants) success of food-based interventions. The IAEA's experience in Chile covering school-aged children provides a good example. In a feeding study using enriched milk powder as a delivery system and Fe stable isotopes as tracers for monitoring the intervention study, it was found that Fe deficiency anaemia decreased from 30% to less than 5% within a year. As result of this study, the Chilean government has modified its policy for pre-school children nutrition, a programme that covered approximately 1.3 million children. Other examples of IAEA studies involve Indonesia, China and Thailand, which have also shown how isotopic and nuclear techniques yield key data that are useful for strengthening national policies.

Determination of Trace Elements in Mineral Water Samples using Total Reflection X ray Fluorescence (TXRF)

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Preliminary results of trace element analysis by TXRF of drinking tap water, various brands of local and imported bottled water samples sold in Nairobi as mineral are presented. The levels of potassium(K) ranged from 0.2 to 28.9 μg/ml, calcium(Ca) 2.2 to 120 μg/ml, titanium(Ti) 11 to 60 μg/l, manganese(Mn)8 to 670 μg/l, iron(Fe)31 to 50 μg/l, copper(Cu) 8 to 30 μg/l, bromine(Br) 9 to 248 μg/l, rubidium(Rb)10 to 40 μg/l, and strontium(Sr)10 to 1000 μg/l. It was found that the local mineral water samples contained higher levels of trace elements especially Mn, Zn, Br, Rb and Sr compared to the imported brands. Principal component analysis of the results revealed three factors with the highest component loadings clustering Rb, Sr, Ca in the first eigenvalue; Ti, Fe, Br, Zn, in the second; Zn, Mn, K in the third. A limited spread of 5–6 mm for a 10μl samples was achievable by completely drying the quartz Suprasil sample carrier in a low pressure (300mbar) oven at temperature of 70°C for 10 hours.

Key Words: TXRF, trace element analysis, mineral water, EDTA, MIBK, preconcentration.

Determination of Iodine Species in Cow Milk by Preconcentration Epithermal Neutron Activation Analysis

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Iodine is an essential trace element for human beings. The main source of iodine is generally food items such as fish and milk. Either the lack or the excess of iodine can cause health problems. Iodine deficiency disorder is fairly common in many countries of Africa and Asia. There exists an increasing interest in the determination of total iodine as well as various species of iodine in milk. One of the problems in the analysis of iodine is the lack of highly sensitive methods. Neutron Activation Analysis (NAA) is one of the techniques, particularly when the irradiation is done using epithermal neutrons which is called ENAA, that can provide low detection limits. These limits can be further improved when ENAA is used in conjunction with an anti-coincidence (ENAA-AC) counting system. We have developed an ENAA-AC method for the determination of ppb levels of iodine. We have also employed chemical separation methods prior to ENAA-AC to measure the species-specific concentrations of iodine in cow milk. We have separated lipid-bound iodine using solvent extraction followed by further fractionation using a silica gel column. We have used ammonium sulfate precipitation to separate protein-bound iodine. We precipitated whole casein-bound iodine at pH=4.6. We separated the inorganic species, such as iodide and iodate, using ion exchange chromatography. We have measured the following iodine concentrations in homogenized milk (milk fat 3.25%): 0.475 ± 0.005 μg mL^{-1} of total iodine, 0.432 ± 0.003 μg mL^{-1} iodide, 0.016 ± 0.005 μg mL^{-1} iodate, 0.013 ± 0.003 μg mL^{-1} of lipid-bound iodine, 0.032 ± 0.002 μg mL^{-1} protein-bound iodine, and 0.026 ± 0.001 μg mL^{-1} casein-bound iodine. We have observed that ENAA-AC is a powerful technique for the determination of iodine and its species when used in conjunction with chemical separation methods. The detection limits are low and the precision and accuracy are high.

Natural Radioactivity Measurement in Spring Waters by the Use of SARAD U/Ra-Disc Method

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High costs and the duration of the conventional radiochemical preparation methods for analysis of radium and uranium are the elements that considerably limit the number of samples that can be analysed. SARAD GmbH group developed U/Ra-disc method that is highly competitive in comparison with standard radiochemical methods (H. Surbeck, 7th Int. Symp. on Environmental Radiochemical Analysis, UK, 1994). The new procedure is based on the selective absorption of uranium and radium at thin, chemically activated layers. These layers are carried by small discs made of Polyamide. The thin films absorb uranium and radium from aqueous solutions, for example from drinking water. The discs are simply immersed into the solution to be measured to absorb and accumulate radionuclides with high efficiency. The alpha spectrum of a water sample with the nuclides of the uranium decay chain can be analysed using a conventional alpha spectrometer.

The purpose of the project is to test the U/Ra-disc method developed by SARAD on several natural water samples. In order to get quantitative results the whole system has to be previously calibrated with respect to the sample volume, the exposition time, temperature and pH of water sample, the detector geometry and the alpha analysis time. The analysis time should be chosen in accordance to the expected nuclide concentration of the sample and the maximum allowable statistical error. The whole project is carried out at the Laboratory of Low Activities, Institute of Physics, University of Silesia, Katowice, Poland.

Energy Requirements and Physical Activity Level of Active Elderly People in Rural Areas of Cuba

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Obesity and NIDDM are common in the Third Age and increasing in Cuba. Among the lifestyle changes associated with increased prevalence of obesity and its related disorders, diet and activity patterns are prime candidates. The transition to this lifestyle model may induce a decrease in the energy needs. There is an urgent need for tools which have been validated for measuring diet and physical activity in nutritional studies in the developing world, but also a more urgent need for reference values for the total energy requirements of healthy elderly people. Regular physical activity reduces the likelihood to develop diseases that characterize the metabolic cardiovascular syndrome. With the purpose of estimating the energy requirements, a group of 48 elderly people aged 61-74 years living in a rural mountain community was submitted to a medical, epidemiological, dietary and biochemical study of the nutritional status. Glucose intolerance was diagnosed in 40% and arterial hypertension was present in 23 % of them. Ten subjects without signs or symptoms of the metabolic cardiovascular syndrome were submitted to a measurement of the total energy expenditure by the doubly labelled water method. PAL values of 2.13 and 1.77 were measured for men and women, values which were significantly higher that the recommended value of 1.51 for elderly subjects. The total energy expenditure The estimation of energy requirements by the energy intake or by the factorial method using the physical activity questionnaires generated values, which were 11% and 30% lower than the values obtained by the DLW method. The value of 1.51×BMR for the estimation of the energy requirements of elderly subjects living in rural areas and submitted to higher levels of physical activity seems to be sub estimated.

New Technology of Diagnostic and Control of a Thyroid Disease Treatment using *in vivo* X Ray Fluorescent Analysis

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It is now determined that the contents of native iodine in a thyroid gland (TG) depended on its function and physiological status and availability of diseases, and also on quantity of iodine in diet. This parameter is indispensable for the doctors for diagnostic, control of efficiency of iodine preventive maintenance and treatment.

In 1968, practically simultaneously in Russia and in USA, it was offered to use X ray fluorescent analysis for research of iodine in TG, but until recently devices and techniques for non-nvasive, secure and not burdensome for patient definition of intrathiroid concentration of iodine were not developed. In Russia in 2000, for the first time, a factory-made system for *in vivo* X ray fluorescent analysis was demonstrated. In its designed use, as sources of exciting radiation — ^{241}AM, as the detector — a semiconductor silicon detector which is working without liquid nitrogen. The measurements of the contents of iodine in TG are carried out to straight method, without using padding measurements (for example, sonography) with usage of a designed original technique.

These installation and technique of definition of a level of iodine have received the permission of the conforming competent organizations of Russia for usage in clinical practice. The lower detection threshold of iodine in TG, at time of measurement 15c, makes 50 µg/g tissues. The measuring error makes 5–20% depending on concentration of iodine in TG.

The technology of definition of concentration intrathyroid of iodine with usage of the called device is simple, reliable and is reproduced, has sufficient sensitivity and throughput capacity. The local radiation dose at such kind of research is very small (less than 0.1 mSv) that allows to inspect a broad quota of population, including children, pregnant and feeding women.

It its ground exploitations of the indicated installations in medical entities of Russia the outcomes of examination of children and adult patients in areas with a mild iodine deficit are debated at different diseases TG.

The medical indications for usage of a designed new technology are established: screening-diagnostic of people having risk to diseases TG; in case of the known diagnosis — severity grade of disease and its forecast; the control efficiency of iodine prophylaxis maintenance and spent treatment.

Estimation of Progesterone in Bovine Milk by Liquid Phase Radioimmunoassay for Veterinary Applications

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Reproductive management is a major concern for the dairy industry which, with inefficient estrous detection, causes significant economic loses. The level of progesterone, which is a steroid hormone of molecular weight 314.5 D, as an early indicator of pregnancy, is becoming increasingly popular. This now has become an essential tool for the veterinarians and the farmers in making early diagnosis and decisions on culling and rebreeding for economic herd management.

The standardization of a direct radioimmunoassay for the estimation of progesterone in bovine milk using ^{125}I-labelled progesterone prepared by radio iodinating the tyrosine methyl ester (TME) conjugated to progesterone and a specific antibody is described. The conjugate was radioiodinated with ^{125}I using chloramine-T and purified by gel-filtration. Radiochemical purity of the tracer was found to be >98%. A set of seven individual progesterone standards in buffer was prepared in lyophilized form. Milk samples for the preparation of progesterone free milk was collected during the heat period. After checking for the non-specific binding and specific binding, in these samples, they were further processed. Potassium dichromate was added to these samples for prolonged storage. Further, the milk was skimmed by centrifuging at 2000g for 15 minutes. Various assay parameters, such as, buffer, volume of the matrix, milk/sample/standard, incubation condition, total reaction volume, and separation system were studied in detail to optimize the assay. Non-specific binding was found to be <5% and specific binding was found to be 30-50%. No blocking agents were added in the milk sample during the assay. The assay involves the incubation of progesterone antibody along with individual standards or sample and radiolabelled tracer for 2 hours at room temperature. The assay range was 0-50ng/ml where the volume of standard/sample was 50μl. The developed assay was further validated where the intra and inter assay precisions were <10% and <15%, respectively. The analytical recovery was found to be 91–115% and the dilution test showed a recovery of 96–104%. End of run effect was found to be <12% and the intra assay precision profile showed the C.V. to be <10% all along the assay range of 0.25–50ng/ml of progesterone.

The levels of progesterone in milk samples at heat period and at various months of pregnancy, as well as after artificial insemination, were analysed by the above developed assay and found to be clinically correlating to the extent of 92%.

Variation of Methylmercury Concentration in Hair of the Kuala Lumpur Residents in terms of Race, Gender, Age and Fish Consumption

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It is well known that the toxicity of mercury varies dramatically with its chemical forms, and methylmercury is the most toxic form of mercury. Therefore, it is important to know the background levels of exposure of human population to methylmercury. Various methods for the determination of methylmercury in environmental and biological samples have been developed. In comparison with other methods, neutron activation analysis when coupled with specific separation procedures, is regarded as the most accurate and sensitive methods for the determination of methylmercury. In this work, simple and efficient extraction technique developed by Sarmani, et al. (1997) has been adapted for the isolation of methylmercury from hair samples collected from donors living in different area of Kuala Lumpur. In this technique, hair samples were digested with NaOH and liberated methylmercury was then extracted into toluene. Ashless filter paper impregnated with 1 % cysteine solution was added into toluene for back extraction of methylmercury. The cysteine paper containing methylmercury was then dried and irradiated together with methylmercury standard for six hours. After three days decay mercury was counted for 30 minutes by a high resolution gamma spectroscopy system. Mercury was determined using both the ^{197}Hg and ^{203}Hg radionuclides via 77 kev and 279.1 kev, respectively. The precision and accuracy of the method were checked by comparing the results of analysis of hair standard reference materials (IAEA 085 and IAEA 086). The results obtained for the reference materials showed good agreement with the certified values. The median values of methylmercury in hair samples of Kuala Lumpur residents was 1.13 mg kg^{-1} in range of 0−4.65 mg kg^{-1} and the median percentage of methylmercury to total mercury was 31.15% with range of 0−75.81%. The highest levels of methylmercury (1.52 mg kg^{-1}) were found in the Chinese followed by Indians (1.31mg kg^{-1}) then Malays (0.75mg kg^{-1}).The level of methylmercury in females (1.25mg kg^{-1}) was found to be higher than those of males (1.03 mg kg^{-1}). A positive correlation was found between methylmercury concentrations and the amount of fish consumed by the population ($r=0.89$, $P<0.01$). There is also a statistically significant correlation ($r=0.26$, $P<0.05$) between age and the level of methylmercury.

Stable Isotope Composition of Food from different regions of Poland

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Stable isotope (hydrogen, oxygen, carbon and nitrogen) composition is an important tool for food authenticity and control of origin. The isotopic fractionation of those elements in the environment follows complex patterns, allowing to establish the correlation between food (fruits, vegetables etc.) and raw materials (water and CO_2).

The aim of the study is to explore the relationship between isotope composition of different sorts of food and its geographical origin. The purpose of the study is to compare the data from different regions of Poland. The samples are received directly from a producer.

Hydrogen, oxygen, nitrogen and carbon composition is measured in many sorts of food. The collected data give a possibility to find the relationship between time and place of origin and isotope ratio: $^{18}O/^{16}O$, $^{13}C/^{12}C$, $^{15}N/^{14}N$ and D/H.

The composition of water presented in food is tested. Hydrogen is measured by H/Device and oxygen isotope ratio, by Gasbench II (both instruments connected with mass spectrometer). For the comparison the water samples from the region of plant growing are tested.

In this study, for measurements of carbon and nitrogen composition in food, we use our new instrument Elemental Analyser coupled with mass spectrometer.

The correlation between stable isotope composition $^{18}O/^{16}O$, $^{13}C/^{12}C$, $^{15}N/^{14}N$, D/H and geographical origin of food will be presented in the paper.

In the future, the study will be continued and addition of parameters, as a sulfur isotope composition in food and in surrounding environment (as a pollutant), will be compared.

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Fast method for measuring the ^{90}Sr Activity with Cherenkov Radiation in Silica Aerogel

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Sr-90 is a highly radiotoxic fission product, which may pollute the environment following an accident in a nuclear power plant. It is a pure beta emitter and thus difficult to detect by standard methods. Recent progress in silica aerogel production as well as the new multi-anode photomultiplier tubes with good single electron counting resolution offer possibilities for detection of Sr-90 based on Cherenkov radiation of beta particles emitted by its daughter Y-90. An appropriate choice of the aerogel refractive index (produced in the range between 1.005 to 1.06) determines the threshold for Cherenkov radiation and thus separates between higher and lower energy beta particles. Also multi-anode PMTs permit the counting of the Cherenkov photon yield, offering additional discrimination. An apparatus was thus constructed for detection of the relatively higher energy beta particles emitted by Y-90 ($E\_max = 2.27$ MeV). The efficiency of the detector and the photon yield as a function of the beta spectrum end-point energy will be presented, as well as results of investigations of various backgrounds and the lower limit of activity required for quick and accurate measurements of environmental samples (air filters or sediments). In the next step a field apparatus will be constructed which will allow easy determination of Sr-90 activity.

Comparison of Liquid-Liquid Extraction and Solid Phase Extraction for Manganese in Water analysed by Neutron Activation Analysis

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The concentrations of total manganese in most natural water systems are in the range of 0.001 to 1.0 mgl^{-1}. The maximum contaminant level (MCL) of manganese in drinking water as recommended by US Environmental Protection Agency (EPA) is 0.05 mg/l. Analytical methods capable of measuring the low level of manganese are necessary for evaluating the quality of natural water. Neutron activation analysis (NAA) is one of the most sensitive techniques for the determination of trace elements. However, direct application of neutron activation for analysis of trace elements in a complex system such as natural waters is generally difficult because of matrix interference. Preconcentration and/or matrix separation procedures are often required before irradiation to eliminate such interferences. In this study two methods based on solid phase extraction (SPE) and liquid-liquid extraction (LLE) has been developed for the extraction of manganese in water prior to irradiation. Experimental parameters such as effect of pH, type and volume of the chelating agent and flow rate were studied and optimized. Analytical parameters such as linearity, precision, accuracy, detection and quantitation limits, and matrix effects for SPE and LLE methods were evaluated for comparison purposes with the aim of selecting the most appropriate depending on the high recoveries and lower detection capabilities required. Both methods can be applied to real samples and give the same results, but SPE allows the high recovery of 99.8 % of manganese with lower detection limit of 0.001 µgl^{-1} as compared to LLE (90.5 % of manganese recovery with lower detection limit of 0.73 µgl^{-1}). Furthermore, the SPE is easily used compared with LLE and not time consuming which allows analysis of a large number of samples.

Irradiation Counting System for Analysing Large Samples by Short-Time Activation Analysis

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A new irradiation and measurement system for short time activation analysis was constructed and installed in our TRIGA-II reactor. The in-core metallic part was fabricated from an aluminium alloy, allowing the analysis of samples 15 mm in diameter (~5 ml). The main part is fitted within a moveable Cd-filter allowing thermal/epithermal irradiation at the same position. The system is installed in one of the F-ring positions at a thermal neutron flux of 2E12 $n.cm^{-2}s^{-1}$.

The counting changer is connected to a special pneumatic cylinder in order to set up the sample-detector distances at seven different positions. This arrangement allows optimizing the counting geometry according to the count rates of the analysed samples and spectrometer performance. The detector is connected to a new digital spectrometer with a Zero Dead Time (ZDT) counting procedure.

A new software package was developed to control the irradiation-measuring sequences facilitating dynamic operations. Thus, the software optimizes the counting geometry and shaping time of each measurement using different techniques, according to the half-lives of the investigated nuclides as well as count rates. The first technique is based on setting the system using conditions pre-defined by the operator to count the samples at certain geometry and shaping time of each measured spectrum. Thus, it is suitable for measuring the very short-lived nuclides. While the second technique is based on automatically determining the optimal geometry and spectrometer throughput. However, the maximum dead time (i.e. 70%) and the lowest aceptable shaping time (i.e. 1µs) must be pre-defined.

A sample exchanger unit was constructed in order to facilitate automatic operation for the analysis of up to 120 samples. This unit is operated pneumatically, and can be implemented for loading different sample sizes. the analytical procedure is controlled with different sensors which can stop the automatic operation at any stage in case of operation failure.

Radiotracers and CFD Methods for Wastewater Treatment Apparatus Investigation

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Using Br-82 and La-142 radiotracers for labeling liquid and solid phases, respectively, the researches of apparatus for wastewater treatment were carried out. The clarifier–equalizer, aeration tanks and sediment settlers were investigated. The models of liquid phase flow were proposed. The parameters of sediment removal processes were determined. Computational fluid dynamic (CFD) methods are used for verification of proposed models in laboratory and industrial scale. Application of CFD methods is an effective tool for prediction of flow pattern changing in apparatus as a function of tank geometry (inflow and outflow localization, baffles etc.).

Soil to Plant Transfer Factor for Radiocesium by Field Measurement

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This paper deals with soil to plant transfer factor of radiocesium (^{137}Cs) considered to be an important parameter while calculating radiological doses due to the potential releases of radionuclides into the environment. In this work, contaminated land containing ^{137}Cs has been investigated as a field experiment for measuring soil to plant transfer factor. Transfer factor values were measured for leafy plants grown in the contaminated land in Atomic Energy Research establishment (AERE) campus, Savar, Dhaka. Soil and leafy plants were collected from the said land. The activities of ^{137}Cs in soils and leafy plants have been measured using high purity germanium (HPGe) detector coupled with associated electronics. Using this measured activities transfer factor of leafy plants at different points were found to be in the range of 2.7×10^{-2} to 4.7×10^{-2} for ^{137}Cs, which is reasonably consistent with the value found in literature. Soil composition characteristics have also been investigated to compare and contrast the measured values of the corresponding radionuclides. This study may provide a reference data for soil to plant transfer factor of radiocesium when calculation of probabilistic dose of human in the vicinity of the above mentioned area is needed. The results may be used to find an indicator plant which will rid the radiocesium contaminated soil and in consequence the environment.

Determination of Elemental Composition and Probable Sources of Atmospheric Aerosol in Tirana by EDXRF Analysis

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The importance of aerosol composition study is directly related with the specific role that aerosol particles play on human health and in different atmospheric parameters. The air pollution monitoring in Tirana has started long ago by measuring some common pollutants, but only during the last years a few attempts have been made for the study of aerosol composition. These were based on the analysis of total aerosol samples collected on cellulose filters using energy dispersive X ray fluorescence (EDXRF) spectrometry.

Recently, with the support of the Albanian Ministry of Environment, an aerosol sampling campaign was organized in Tirana. Two different stations were selected for collecting aerosol samples. The first was situated in the centre of the city while the second, in a clean area, near the top of the mountain Dajti. In each of the stations total and size-fractionated aerosol samples were collected respectively on TFA-41 cellulose filters using high volume pumps and on Nuclepore filters using stacked filter unit sampler.

An experimental EDXRF system was used for the determination of the concentrations of about 15 elements in the aerosol-loaded filters. The analytical data obtained allowed the calculation of the mean elemental concentrations in the aerosol and their crustal enrichment factors. The application of multivariate methods (Factor Analysis) allowed the identification of the main aerosol sources.

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Importance of the Speciation of Radionuclides for the Calculation of Transfer Coefficients: Application to Soil-Fungus Transfer

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Transfer coefficients are commonly used as an approximation to the problem of quantifying the transit of radionuclides between an ecosystem's different characteristic receptor media. These coefficients are traditionally defined as the quotient between the specific activities of the receptor and the donor compartments. In the present study, the receptors were edible mushrooms and the donor, the soil.

However, not all the radioactive contents of a soil are in a condition to be transferred. Instead, the fraction that is available will depend intimately on the capacity of the different compounds to which the radionuclides are associated to be taken up by the fungus.

To analyse the cited capacity, we carried out a scheme of chemical speciation of the surface layer (0-5 cm) of the soils corresponding to two forest ecosystems (pine woods) that present a high productivity of mushrooms. This scheme consists of the sequential extraction of the available soil fraction (extractable with NH_4OAc), that soluble in dilute acid (extractable with HCl 1M), that soluble in strong acid (extractable with HCl 6M), and the residue.

We analysed the presence of different man-made (^{137}Cs, ^{90}Sr) and natural (^{40}K, ^{226}Ra) radionuclides in each of the soil fractions enumerated above and in two representative species of mushroom from the aforementioned two ecosystems: *Hebeloma cylindrosporum* and *Lactarius deliciosus*.

Specifically, more than 75% of the concentrations of ^{40}K and ^{137}Cs present in the soils studied were found bound to fractions not accessible to exchange reactions (the fraction soluble in strong acid and the residue). This implies that they are not associated to chemical compounds capable of being transferred to the fungi's fruiting bodies. Therefore, it is totally inappropriate to calculate the transfer coefficients in the usual way, since this uses the total activity found in the soil layer being considered. By way of example, for ^{40}K the traditional method underestimates the transfer by approximately two orders of magnitude. We hence propose another approach, considering only the fraction of radionuclides present in the soil that are really in condition to be transferred.

Organically bound Tritium, OBT: its true Constitution

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Tritium, which is analytically determined to be non-exchangeable bound in tissue solids, is assumed to be bound to carbon. Furthermore, it follows that the biochemical passways by photosynthesis or enzymatic transfer reactions are retarded by the kinetic isotope effect leading to discrimination of tritium in biomolecules.

In contrast, the logistic growth analysis of plants discloses a larger intrinsic growth rate of OBT than of OBH, resulting in tritium accumulation in biomolecules. Exchange experiments providing fractionation factors of 1.4 and 2 confirm this accumulation.

In summary a large~~r~~ part of the so called OBT is not carbon bound but consists of tritium positioned in hydrogen bridges of biopolymers which have been occupied during formation of the molecules and which became later inaccessible for exchange (so called buried hydrogens). Furthermore, there are experimental results indicating even rapid exchange during the *in vivo* state but inhibited in the *in vitro* state, which is commonly given in biosamples prepared for analysis.

Investigations on the Bioavailability of ^{137}Cs and $^{239+240}$Pu in Aerosol and Dust Samples by Fractional Extraction

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The bioavailability of ^{137}Cs and $^{239+240}$Pu in soil, deposited dusts from grassland and streets and in aerosols has been investigated. The host phases of ^{137}Cs and $^{239+240}$Pu were determined by a sequentiel extraction based on the Tessier method followed by gammaspectrometric determination of ^{137}Cs and radiochemical separation and alphaspectrometric determination of plutonium. The radiochemical separation of $^{239+240}$Pu was based on TTA extraction, $La(OH)_3$ coprecipitation and extraction chromatography with TEVA-Spec columns. Counting samples for alpha spectrometry were prepared by electrodeposition.

In aerosols, 47% to 57% of ^{137}Cs were found to be easily exchangeable. The data are in agreement with those of other authors and differ significantly from those for soil and dust samples collected on a nearby street and grassland where ^{137}Cs was quantitatively found in the acid-soluble fraction and the residue. Thus, the bioavailability of ^{137}Cs in aerosols can be expected to be much higher than in deposited dusts and soil.

47% of $^{239+240}$Pu in airborne dust was associated to the organic fraction, while in soil and grassland dust samples, 63% to 75% of $^{239+240}$Pu was found in the acid-soluble fraction. In street dust, 53% of $^{239+240}$Pu was associated to the oxide fraction. As for ^{137}Cs, the association of $^{239+240}$Pu in aerosols was found to be very different from those in deposited dusts and soil. There seem to be no data available in the literature for comparable aerosol and street dust samples.