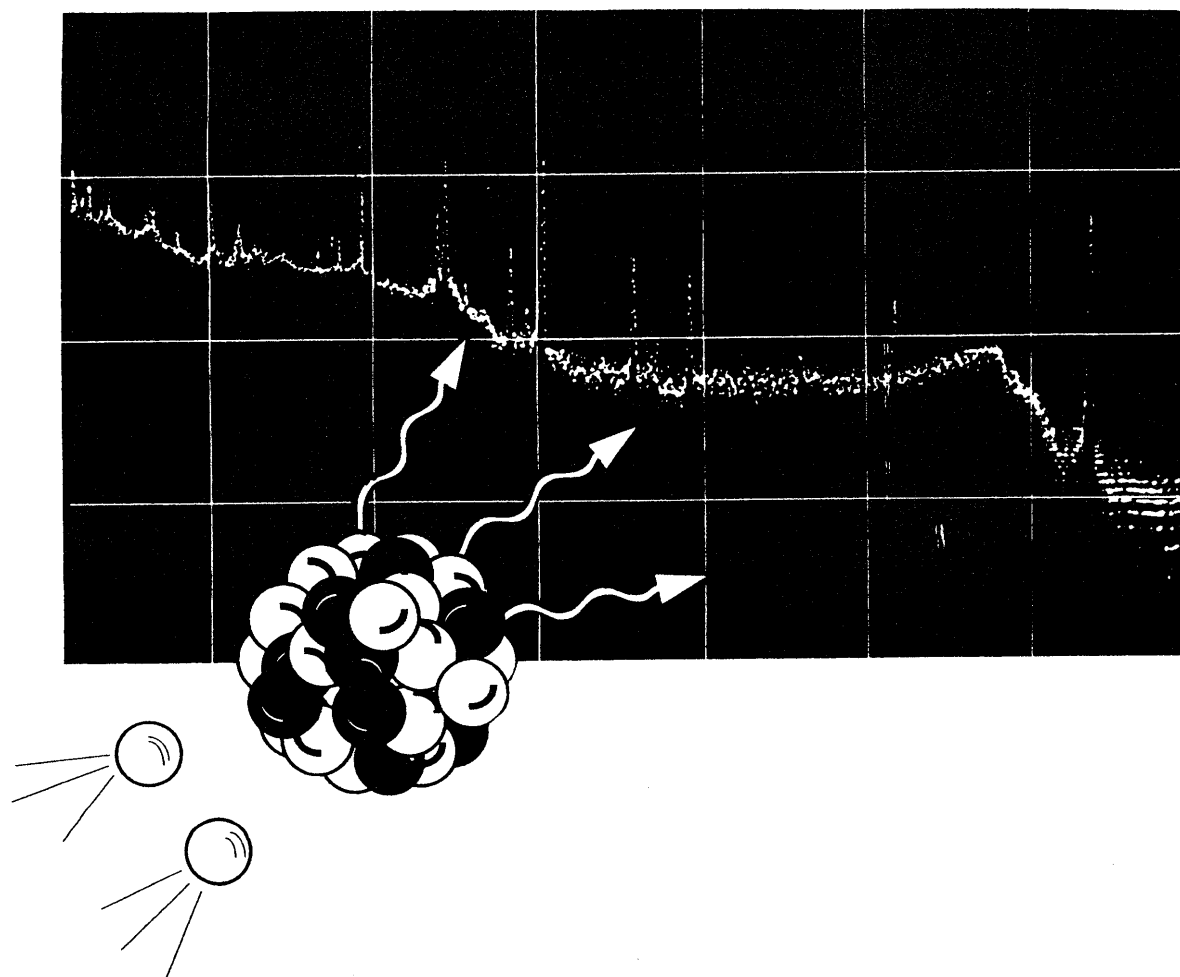


2007年1月

放射化分析

No.21



放射化分析研究会

放射化分析研究会

Japan Association of Activation Analysis

(JA³)

会誌

「Activation Analysis」

表紙図案は 岡田往子さん（武蔵工大・工学部）によるものです。

放射化分析 No.21

目次

特集 「中国の中性子放射化分析事情」

はじめに	大浦泰嗣	1
Nuclear Activation Techniques in China	Chai Zhifang	3
Neutron Activation Analysis in China: Present Status and Future Perspectives	Zhiyong Zhang ¹ and Zhifang Chai	4
Post-k ₀ Studies on Parametric NAA in CIAE	Tian Weizhi, Ni Bangfa, Wang Pingsheng, Huang Donghui, Zhang Guiying, Liu Cunxiong	23
Study of the Chromium Metabolism and Speciation in Diabetic Rats by Enriched Stable Isotopic Tracer Technique Combined with Neutron Activation Analysis	W. Y. Feng, W. J. Ding, Q. F. Qian, Z. F. Chai	30
Preliminary Studies on Determination of Trace Platinum in Airborne Particulate Matter by Instrumental Neutron Activation Analysis	Li Xiaolin, Mao Xueying	39
Study of Organohalogenes in Yogurt and Apple by Neutron Activation Analysis and Related Techniques	Hong Zhang, Zhifang Chai	46

研究会報告

MARC VII	福島美智子	54
FNCA2006	大浦泰嗣	65
2006 日本放射化学会年会・第50回放射化学討論会 記念大会	松尾基之	70

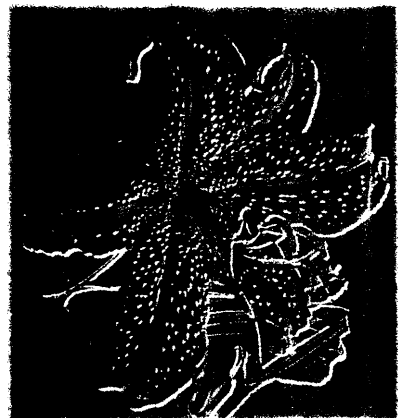
施設便り

原子力機構施設共同利用研究		73
京都大学原子炉実験所		74
東北大学原子核理学研究施設		75

事務局より

拡大幹事会議事録		76
第50回放射化学討論会 放射化分析分科会報告		77
放射化分析冬の学校(京大炉専門研究会)		79

カレンダー
編集後記
会員名簿
広告



特 集

中国の中性子放射化分析事情

はじめに

首都大学東京大学院理工学研究科 大浦泰嗣

海外シリーズの第二弾として中国を取り上げました。中国では日本の JAEA に当たる中国原子能科学研究所(China Institute of Atomic Energy)の 3 基をはじめとして 14 基の研究炉が運転中で、さらに 2 基が建設中です(IAEA Research Reactor Database により)。そのうち、10 基が放射化分析に利用されています(論文 1 より)。国土や人口の違いがありますが、研究炉の数だけを見ると日本と比べうらやましい状況にあります。末尾に、著者が調べた中国の研究炉一覧を載せます。

本特集に当たり中国科学院高能物理研究所 (Institute of High Energy Physics)・柴之芳教授に紹介内容の検討や執筆者の人選をしていただきました。本特集は下記 6 論文からなります。

1. 中国における放射化技術. Chai Zhifang
2. 中国における中性子放射化分析, 現況と展望. Zhiyong Zhang et al.
3. CIAE における k_0 -NAA 法の補正の研究. Tian Weizhi et al.
4. 濃縮安定同位体トレーサと中性子放射化分析を組み合わせた糖尿病ラット中のクロム代謝とスペシエーションの研究. W. Y. Feng, et al.
5. 機器的中性子放射化分析法による大気浮遊粒子中の微量白金濃度定量の予備的研究.
Li Xiaolin et al.
6. 中性子放射化分析と関連技術によるヨーグルトとリング中の有機ハロゲン物質の研究.
Hong Zhang et al.

1 は、柴先生による本特集のカバーペーパーで、2 は、中国での中性子放射化分析分野の活動の総説です。最近の論文が多く引用されており、状況を知るには大変有用です。3~6 は NAA を用いた研究例です。3 は、初期の頃から k_0 -NAA を研究しているグループの論文で、 k_0 法でより正確な定量値を得るための補正法に関して述べられています。4 は、糖尿病ラットでのクロムの代謝を調べた研究で、安定同位体 ^{50}Cr をトレーサとして投与し、NAA で検出しています。5 は、大気浮遊粒子に含まれる極微量白金の定量を INAA で行なうための予備研究で、 γ 線測定上の妨害核種 ^{47}Sc の補正について検討しています。6 は、ヨーグルトとリングに含まれる有機ハロゲン物質

を NAA で定量する研究で、照射前に形態別に化学分離を行なっています。

本特集を読んで皆さんどの様に感じられるでしょうか。その周辺技術に関することも含め放射化分析に関してアジアの中でもっとも活発に研究が進められているといっても過言でないのではないのでしょうか。いい研究協力体制が築けないかな、と感じます。

なお、1980 年代の状況は 1 の論文に引用されている参考文献 1 でレビューされています。放射化分析に利用されている施設の簡単な紹介もあります。

中国で放射化分析に利用されている研究炉*

名前	機関	出力	熱中性子束 [n cm ⁻² s ⁻¹]	所在地
HWRR-II	CIAE	15 MW	2.4×10 ¹⁴	北京市
SPR IAE	CIAE	3.5 MW	4.0×10 ¹³	北京市
MNSR IAE	CIAE	27 kW	1.0×10 ¹²	北京市
TSINGHUA	清華大学	1 MW	1.3×10 ¹³	北京市
MNSR-SH	SIMT	30 kW	1.0×10 ¹²	上海(Shanghai)市
MNSR-SD	RIGS	33 kW	5.0×10 ¹¹	山東(Shandong)省
MNSR-SZ	深圳大学	30 kW	1.0×10 ¹²	広東省深圳(Shenzhen)市
SPRR-300	INPC	3 MW	6.0×10 ¹³	四川(Sichuan)省夹江县
?(TRIGA III)	?	?	?	陝西省西安市
?	?	?	?	四川省

* IAEA Research Reactor Database[<http://www.iaea.org/worldatom/rrdb/>]と柴之芳教授からの情報による

SIMT: SHANGHAI INSTITUTE OF MEASUREMENT & TESTING TECHNOLOGY

INPC: SOUTHWEST INST. OF NUCLEAR PHYSICS & CHEMISTRY

RIGS: RESEARCH INSTITUTE OF GEOLOGICAL SCIENCE

?: 軍所有の炉のため詳細不明。民間利用可。

Nuclear Activation Techniques in China

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The earliest activity of nuclear activation analytical technique in China can be traced back to the early 1950s. After the first nuclear reactor and low-energy cyclotron were built in 1958, the nuclear analysis in China has experienced a rapid growth period characterized by development of various nuclear analytical methods and their extensive applications in multidisciplinary fields, especially in geological, biological, material, forensic, environmental and archeological sciences.

Nowadays, there are about 10 research reactors and over 100 low-energy accelerators available in China for various nuclear analytical activities. A new high neutron flux reactor called the Chinese Advanced Research Reactor (CARR) will reach the full power by the end of 2007, which would provide the neutron flux of 8×10^{14} n/cm²/s.

Over 20 Chinese institutions are being involved in nuclear activation, in which Institute of High Energy Physics, China Institute of Atomic Energy, Shanghai Institute of Applied Physics, China Institute of Engineering Physics, Sichuan Polytechnic University, Shenzhen University, etc. are very active in this field. A Chinese subcommittee for activation analysis was formed in the late 1970s, which is responsible for organizing the national series conferences of activation analysis. Since 1978 eleven conferences have been held with average 100 participants each.

Recently, the Chinese government has defined six national goals as a guideline of major research direction, i.e. agriculture, human health, environment, energy and resources, materials, and information, which are becoming a strong impetus to pursue the development of nuclear activation.

In this special issue, a review paper and other 4 original manuscripts are selected to briefly introduce the latest achievements made by Chinese activation analysts. I would like to emphasize that such 5 papers, of course, are incapable to fully demonstrate the whole trends of Chinese activation analysis. However, they could open a window to Japanese colleagues to know somehow about the present status of activation analysis in China.

Neutron Activation Analysis in China: Present Status and Future Perspectives

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In this review, the recent developments and applications of neutron activation analysis (NAA) since the year 2000 in China is presented, which will mainly include NAA methodology and its applications in multidisciplinary research, e.g. geology, biology, environmental sciences, archaeological sciences, industry, etc. Numerous advances in this field fully demonstrate that the neutron activation analysis is still active as so ever and will continues to flourish in China.

Introduction

Seven decades have past since George von Hevesy first established neutron activation analysis in 1936 for elemental analysis. With the advent of nuclear reactors in the 1950s, neutron activation analysis came into prominence. The earliest activities of NAA in China can be traced back to the early 1960s, shortly after the first Chinese research reactor was built in 1958^[1]. Commercially available high resolution germanium detectors in the 1960s revolutionized the satisfactory analysis of complex γ spectra obtained from the neutron-irradiated samples. Better computing hardware and software of the 1970s and 1980s made neutron activation analysis well established and versatile for the trace element analysis of biological, geological, environmental and other materials. Up to now, activation analysis research and applications have been carried out in more than 20 institutions throughout China.

Methodological Research

Hardwares

Nowadays there are 10 research reactors available in the mainland China (one high flux reactor with

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neutron flux of 1×10^{14} n/cm²/s, one heavy water reactor with 8×10^{13} n/cm²/s, 4 swimming-pool type reactors with 2×10^{13} n/cm²/s and 4 miniature neutron source reactors (MNSR) with 1×10^{12} n/cm²/s. It should be mentioned that five MNSRs have been exported to foreign countries^[2]. A new high flux (8×10^{14} n/cm²/s) reactor, the China Advanced Research Reactor (CARR), is being built at China Institute of Atomic Energy (CIAE), which, hopefully, will be completed in 2007.

Small neutron generators using the deuterium (²H) - tritium (³H) reaction are the most common accelerator-based (as opposed to isotopic) neutron sources. Neutrons are produced by bombardment of accelerated deuterium ions on a tritium or deuterium target. Neutron generators possess the advantages in comparison with isotope neutron sources. Sealed tube neutron generators can be easily turned off; in this way no radiation exposure exists. They may be operated either as continuous or pulsed neutron sources. The neutrons produced are monoenergetic (2.5 MeV or 14 MeV). The 14 MeV neutrons are sufficiently energetic to excite (n, n'γ) reactions for analysis of nitrogen and oxygen, which are particularly important in many applications. Systems for analysis of cement raw meal and coal of low caloric power, and explosives detection based on neutron-induced prompt γ ray analysis have been developed at Radiation Technology Institute of Northeast Normal University^[3-10].

Softwares

An automatic data processing system for reactor NAA has been designed by A et al^[11-13]. The system has functions of radionuclide identification, *f* and α calculation, *K*₀ value measurement, quantitative calculation of elemental concentrations, nuclide data management and experimental design, etc. The analytical methods used in this system include absolute method, relative method and *K*₀-method. Ni et al.^[14] also established a PC controlled automatic NAA system. The unique features include self-validation functions in peak analysis, standardization, interference correction, choice of indicator/analytical line in software, automatic cycling of sample transportation-counting-data acquisition and reduction for an unlimited number of samples, and automatic ordering of the counted samples for the next round of counting in hardware. The combination of well-validated QC procedure and automatic counting system yields a high throughput with no cost in analytical quality.

Chemical procedures involved in NAA

Preconcentration and radiochemical separation. In preconcentration and radiochemical neutron activation analysis of geological samples, attention has been focused on two element groups, the rare earth elements (REEs) and the platinum group elements (PGEs). A set of simple and effective preconcentration

and radiochemical separation schemes has been established for their analysis^[15-17].

Molecular activation analysis (MAA). The MAA is a variety of activation analysis methods that is able to provide the information on chemical species of elements of interest in a specimen of interest, although its exact definition remains to be assigned^[18]. The so-called MAA is, in fact, a combination of conventional NAA with physical, chemical or biological separation procedures in order to meet the ever increasing need for chemical species study. Recently, study of the chemical species of a number of trace elements in biological, environmental and geological samples has been extensively performed by MAA at Institute of High Energy Physics, the Chinese Academy of Sciences. A review of the methodology, merits and limitations of MAA for chemical speciation study has been published^[19]. Selected publications on MAA are listed in Table 1.

Table 1 Selected publications on MAA

Matrix	Elements determined	Separation Technique	Reference
Coal	As	Sequential extraction	20
Water	As	Extraction, co-precipitation, and ion exchange chromatography	21, 22
Rat liver	As	Differential centrifugation	23
Geological samples	Au	Sequential extraction	24
Aerosol	Cl, Br, and I	Extraction	25
Pine needle	Cl, Br, and I	extraction	26
Milk and yoghurt	Cl, Br, and I	Extraction	27-30
Rat organs	Cr	Differential centrifugation and gel chromatography	31-33
Cr-yeast	Cr	Sequential extraction	34, 35
Human liver	multielement	Differential centrifugation and gel chromatography	36-39
Marine alga	multielement	Sequential extraction	40
Aerosol	multielement	Sequential extraction	41
Cancer tissue	multiment	Differential centrifugation	42
Rock	PGEs	Sequential extraction	43
Plant	REEs	Differential centrifugation and sequential extraction	44-49
Rat liver	Sm and Yb	Differential centrifugation	50

Certified reference materials and biological environmental specimen bank

Certified reference materials (CRMs) are an important tool in achieving measurement compatibility. One

of the possible approaches in producing such materials is to organize the worldwide interlaboratory comparisons. NAA plays a very important and sometimes unique role in the homogeneity checking and certification of CRMs. RNAA has been used for the determination of eight rare earth elements in two biological Chinese CRMs^[51]. These determinations are important for possible certification of the above mentioned ultra-trace elements.

The first biological environmental specimen bank in China with international guidelines was established in Key Laboratory of Nuclear Analytical Techniques (Beijing and Shanghai), the Chinese Academy of Sciences^[52-54]. The retrospective analysis of specimens long-term stored in the biological environmental specimen bank allows conclusions to be drawn as to the trend in and the current status of the pollution of different ecosystems by "new" (harmful) substances.

Comparison of NAA with other analytical techniques

During the past three decades, various non-nuclear techniques for trace element determination have emerged and they are widely being used, thereby strongly competing with NAA in respect to various analytical characteristics. In particular inductively coupled plasma mass spectrometry (ICP-MS) has shown to be a powerful technique for multi-element analysis. Several authors^[51, 55-56] compared the advantages and drawbacks of NAA and ICP-MS. Both methods have specific advantages that put them beyond competition for certain applications. Although ICP-MS can replace NAA for many routine analyses, NAA remains essential as a highly reliable and accurate reference method.

Applications of neutron activation analysis

Similar to the international development trends, NAA researches in China are also focused on applications, especially in geological, life, and environmental sciences.

Geoscience

Geoscience is a traditional and important application area for NAA. Studies in PGEs contents in rock and sea water samples have been reported^[83-92]. Dai et al.^[61] established an analytical method for Ir in sea water based on NAA and α -amino pyridine preconcentration. The detection limit is 10^{-16} g/ml. There are numerous publications on REE and other trace element concentrations in geological samples for studying the geological structures, magma generation, and depositional environment. NAA was also employed to dating,

ore prospecting, and identification of diamond, gem, and jade.

Table 2 Application of activation analysis in geoscience

Sample	Element determined	Description	Reference
Hydrothermal sediment	Ag, Pb	Enrichment mineralization	57
Rock	Au	ore prospecting	58, 59
Rock	Au	Speciation analysis	24
Geological samples	Co, Ir	dating	60
Sea water	Ir	Chemical behavior	61
rock	multielement	geochemistry	62-75
diamond and jade	multielement	identification	76, 77
meteorolite	multielement	Composition analysis	78, 79
Water body	multielement	geochemistry	80
Geo-gas	multielement	Ore forming	81, 82
Geological samples	PGEs	Distribution and geochemistry	83-92
Boundary samples	PGEs	catastrophic environment	15, 16, 43
fossil	REEs	catastrophic environment	93
asphalt	REE and other elements	organic mineralization	94

Life sciences

The study of trace elements in life sciences has been developed from bulk composition analysis, correlation between total contents or concentrations of one element and another, and corresponding synergetic or antagonistic effect to speciation analysis. Applications of NAA in life sciences are also closely involved in these topics. Selected publications of this area are summarized in Table 3.

Environmental science

Environmental science is one of the most popular applications of NAA. With the exception of lead, almost all environmentally important heavy metals can be determined by NAA. NAA of air samples has been in existence for more than three decades and it continues to be a popular method of choice. Air pollution monitoring in Beijing, Chengdu, Hongkong, Tangshan, Helan Mountain, and Wali in Qinghai Province have been carried out. Studies on background values of multielements in water and soil, relations between trace elements and endemic diseases, biomonitoring of air pollution, environmental changes and paleoenvironment, soil erosion, and coal-burning pollution have been reported. A particularly interesting application in this area is the separation of organic halogen compounds from inorganic forms and determination of the organic fraction by NAA. Extractable organohalogens in moss, pine needle, aerosol, milk and yoghurt samples have

been evaluated.

Table 3 Application of activation analysis in life sciences

Sample	Element determined	Description	Reference
Rat liver	As	Subcellular distribution	23
Cr-yeast	Cr	Chemical species	34, 35, 95, 96
Rat organs	Cr and other elements	diabetes	31-34, 97
teeth	F	concentration	98
egesta	Fe	Bioavailability	99, 100
thyroid gland	I	concentration	101
Rat thyroid gland	I	cretinism	102
Marine algae	I	Chemical species	40
Human organs	Na, Cl, K, Ca, and P	cancer	103, 104
egg	Ir	metablism	105
hair	Multielement	concentration	106
Rabbit brain	Multielement	cerebral iscbemia	107
Rabbit iliac crest	Multielement	osteoporosis	108, 109
Human liver	multielement	Corelation between elements	110
Rat brain and organs	multielement	Neutrotoxicity of Hg	111
Rat brain	multielement	Neutrotoxicity of La	112
Rat ilium	multielement	osteoporosis	113
Rat organs	Rare earth elements	distribution	50, 114
plant	Rare earth elements	Distribution and chemical species	44-49
Crop and fruit	Rare earth elements	Absorption and distribution	115-118
Human liver	Se and other elements	Chemical species	36-39
egesta	Zn	Bioavailability	119

Archaeological sciences

The use of neutron activation analysis to characterize archaeological specimens and to relate the artifacts to source materials through their chemical fingerprints is a well-established application. Applications of NAA in the source study of raw material of the terracotta warriors and horses from the pits terracotta warriors and horses from the Pits No.1 and No.3 of he first Chinese Emperor Qin Shihuang's Mausoleum have been carried out^[188-192]. The results showed that the Lishan clay might be considered as the origin of raw materials for the Terracotta Warriors and Horses in Qin Shihuang's Mausoleum; thus the kiln sites might also be located near the Qin's mausoleum. An ancient Chinese ceramic specimen bank has been established in Key Laboratory of Nuclear Analytical Techniques, the Chinese Academy of Sciences for provenance and dating study of ancient Chinese ceramics. Up to now, the specimen number in the bank amounts to over

Table 4 Application of activation analysis in environmental sciences

Sample	Element determined	Description	Reference
Human hair	As and other elements	endemic arsenic disease	120
Water, soil, and foodstuff	As and other elements	endemic arsenic disease	21, 121, 122
coal	As and heavy metals	Coal-burning Pollution	20, 123-145
Atmospheric aerosol	As, Au, Brand other elements	atmospheric environment	41, 146-154
fish	Hg ,Se and other elements	Corelations between Hg and other elements	155
Dinosaur egg	Ir and other elements	paleoclimate	156
Moss and lichen	multielement	Biomonitor of air pollution	157-159
sediment	Multielement	Environmental Changes	160, 161
Natural water	Multielement	background values	162
soil	Multielement	soil erosion	163-166
Antarctic Lake Core	Multielement	envlrommental change	167, 168
natural sediment	Multielement	sediment movement	169
soluble humic acid	Na and Cl	Characteristics of water soluble soil humic acid	170
foodstuff	Organohalogens	Food contamination	7, 9, 10, 171-174
Plant materials	Organohalogens	Air pollution	6, 175-178
Atmospheric aerosol	Organohalogens	Air pollution	179-181
Sediment core	Rare earth elements	sediment origin	182
soil	Rare earth elements	soil erosion	183-187

Industrial applications

Pulsed fast-thermal neutron analysis (PFTNA) is a bulk material analysis technique, which makes it suitable for industrial analysis. PFTNA utilizes the $(n, n'\gamma)$, $(n, p\gamma)$ and (n, γ) reactions to identify and quantify a large number of elements, such as H, C, O, N, Na, Si, S, and Cl. Applications of PFTNA on oil and mineral exploration^[204-207], on-line coal analysis^[208-212], and on-line cement analysis^[213] have been reported. PFTNA method combined with artificial neural network has been used for explosive detection^[214].

Perspectives

In the past two decades, rapid development of various multielement analytical techniques, such as ICP-MS, has shown these techniques to be superior in a number of cases, where NAA earlier was the technique of choice. However, the recent status indicates that these newly-emerging techniques have never completely replaced NAA, simply because the NAA still possesses some unique features, not easily challenged by other non-nuclear techniques. It is foreseeable that the NAA with the following advanced characteristics in sensitivity, precision, reliability, accuracy, penetrability and *in situ* analysis (e.g. for PFTNA), are still desirable for the tremendous development of science and technology in future.

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Post- k_0 Studies on Parametric NAA in CIAE

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Since the publication of the basic expression of k_0 -NAA in mid-1970s, a series of follow-up studies was carried out in our laboratory. Some of major ones, including parametric corrections for fission and threshold reaction interferences, parametric normalization for efficiencies from different counting positions, k_0 -NAA for major non- $1/v$ activation reactions, and estimation and parametric corrections for neutron flux self-shielding effects, are to be briefly described in this paper.

Introduction

The idea of calculating elemental concentrations directly using activation equation, so-called absolute method, was initiated at very early days of NAA history¹. Due to the unavailability of accurate nuclear data (effective cross sections, half-lives, etc.) and experimental parameters (neutron fluxes, detection efficiencies, etc.), however, absolute method of NAA has never been popular. Instead, relative method based on elemental standards (known amount of elements of interest) has been unlimitedly used in almost all the NAA laboratories worldwide up to mid-1970s. The advent of high resolution Ge γ -ray spectrometry in 1960s made NAA truly non-destructive and multielemental. It was the desire of many activation analysts then to have a nearly-absolute method to eliminate making, irradiating and counting of the standards of multielements, to determine the unexpected elements, and to better computerize the data reduction, without sacrifice in accuracy. Examples of some early attempts include “single comparator” method proposed by Girardi et al.² for fixed irradiation condition and fixed detection system and “k” method proposed by De Corte et al.³ for flexible irradiation condition and fixed detection system. The basic expression of “ k_0 ” method proposed by Simonits et al.⁴ established a framework of parametric NAA on both flexible irradiation condition and flexible detection system for $1/v$ analytical reactions.

Follow-up studies conducted in our laboratory dealt mainly with: how to make parametric determinations for elements with non- $1/v$ analytical reactions; how to make parametric corrections for nuclear reaction interferences; how to make parametric normalizations for peak count rates obtained from different counting positions; and how to make parametric evaluations and necessary corrections for neutron flux self-shielding effects.

Parametric NAA for non-1/v analytical reactions^{6,7}

Necessity - One of the basic preconditions of primary k_0 – NAA is for the analytical reactions to obey the Hogdahl convention based on 1/v reactions⁴, i.e., $\sigma_{th} = \sigma_0$. Although large majority of elements have 1/v analytical reactions, there are a few exceptions. The most sensitive analytical reactions of three important elements, Eu, Lu (REEs), and Ir (PGE), are non-1/v ones.

Feasibility - For non-1/v reactions, Hogdahl convention should be replaced by generalized Westcott convention, where $\sigma_{th} = g(T_n) \sigma_0$, g is a function of neutron temperature T_n . The theoretical $g(T_n)$ values for these three reactions are listed in Table 1⁵.

Table 1. Theoretical $g(T_n)$ for three non-1/v reactions⁵

$T_n, ^\circ\text{C}$	40	60	80	100
¹⁵¹ Eu (n, γ)	0.883	0.865	0.849	0.834
¹⁷⁶ Lu (n, γ)	1.83	1.97	2.10	2.24
¹⁹¹ Ir (n, γ)	1.035	1.037	1.040	1.042

Solution - “Working k_0 ” may be determined for given type of samples and certain range of irradiation conditions (to keep T_n within narrow range (5 – 10 $^\circ\text{C}$)) by using CRMs certified for these three elements.

As an example, working k_0 s for these three reactions have been determined for typical geological samples irradiated for 6 – 20 h at random heavy water reflector channels of the 15 MW HWRR at CIAE, as listed in Table 2^{6,7}. These values have been successfully used for NAA of several thousand samples.

Table 2 Working k_0 values for three non-1/v reactions^{6,7}

Reaction	E_γ, keV	$k_{0,\text{Au}} (\text{exp})$	$k_{0,\text{Au}} (\text{cal})$
¹⁵¹ Eu (n, γ)	1408	8.44±0.26	8.04
¹⁹¹ Ir (n, γ)	316	3.12±0.11	3.02
¹⁷⁶ Lu (n, γ)	208	0.139±0.07	0.0714 ($g = 1$), 0.14 ($g = 1.965, T_n = 60 ^\circ\text{C}$)

Note that the working k_0 for ¹⁷⁶Lu (n, γ) is 0.139, equivalent to $g \approx 1.965$ and $T_n \approx 60 ^\circ\text{C}$, indicating the “neutron thermometer” function of this reaction for estimating the effective neutron temperature during irradiation and calculating working k_0 values of other non-1/v reactions.

Parametric corrections for fission interferences⁸

Necessity – 1) Depleted U is increasingly used in U reagents production. Using random U reagents for “interference standards” may suffer underestimation of fission interference contribution. A parametric correction is therefore required to check the isotopic abundance of ²³⁵U in U “interference standards”, or to be used independently; 2) It is an extension of k₀-NAA from analytical to interference reactions.

Feasibility – 1) Thermal neutron-induced ²³⁵U (n,f) reaction basically obeys 1/v law, allowing the use of k₀ concept; 2) The Q₀ value of ²³⁵U (n,f) reaction is very small (0.472) and f values are typically in the range of 10 – 300, therefore the uncertainty propagated from Q₀ to f + Q₀ and Ik₀ is largely reduced (see Eq. (1) below).

Solution – Based on k₀ concept, an Ik₀, i.e. interference k₀, is proposed for each fission interference case, as defined by Eq. (1)⁸.

$$Ik_0 = \frac{M^* \theta \gamma \sigma_0 Y_s}{M \theta^* \gamma^* \sigma_0^*} (\text{theory}) = \frac{A_{sp} \varepsilon^* f + Q_0^*}{A_{sp}^* \varepsilon f + Q_0} (\text{experiment}) \quad (1)$$

where, parameters with asterisk refer to analytical indicators, parameters without asterisk refer to corresponding interference fission products, Y_s is mass yield of fission induced by subcadmium spectrum neutrons; A_{sp}/A_{sp}* is interference factor.

Ik₀ values for 8 major fission interference reactions belonging to three types (A – same nuclide, same growth-decay pattern, as shown in Table 3; B – same nuclide different growth-decay pattern, ¹⁴⁰Ba-¹⁴⁰La; and C – gamma spectral interferences from different nuclides, ¹³¹Ba-¹⁰³Ru) were experimentally determined at 6 channels of 3 research reactors with f values ranging from 13.7 to 134, and their neutron spectrum independent nature verified.

Parametric corrections for reactor fast neutron induced threshold reaction interferences^{6,11,12,13}

Necessity – 1) Ever increasing demand for ultratrace analyses requires the use of highest possible reactor neutron flux, that usually means harder neutron spectrum and more serious threshold reaction interferences; 2) Traditional way of determining interference factors by co-irradiating pure interference element standards often suffers overestimation contributed by (n,γ) reactions of trace impurities of the elements of interest contained in “pure” interference standards, since the difference in Z for interfering elements and the elements of interest is 1 (for (n,p)) or 2 (for (n,α)) and often co-exist in nature; 3) This problem may be solved by

Table 3 Determinations of k_0 for six type A cases⁸

Nuclide	Reactor						k_0 exp.	k_0 calc.
	HWRR	SPRR		MNSR	f			
	134	32.8	37.7	31.6	33.7	13.7		
⁹⁵ Zr	11.0	10.6	10.8	10.8	10.1	10.9	10.7±0.3	11.6
⁹⁷ Zr		172		162	194		176±16	171
⁹⁹ Mo	3.00	3.00	3.33	2.91	2.90	3.75	3.12±0.35	3.27
¹⁴¹ Ce	0.250	0.253	0.295	0.304	0.295	0.280	0.280±0.022	0.28
¹⁴³ Ce		1.23	1.34	1.32	1.26	1.33	1.28±0.06	1.37
¹⁴⁷ Nd	0.25	0.24	0.26	0.26		0.23	0.247±0.012	0.274

These values were later referenced by and incorporated in literature^{9,10}.

successive bare and Cd (or B) covered irradiations and solving simultaneous equations. However, it is obviously too complicated to be used in routine analysis; 4) In addition to the requirements from the above-mentioned aspects, a parametric correction method for threshold reaction interferences will also be an expansion for k_0 -NAA.

Feasibility – Approximate primary fission neutron spectra were verified for fast neutron energy distributions at random channels of three research reactors by using reference threshold reactions with accurately known fission neutron spectrum averaged cross-sections and wide spread effective threshold energies. An example on the verification of reactor fast neutron energy distribution having an approximate primary fission neutron spectrum and the determination of this equivalent fast neutron flux, ϕ_f , is given in Table 4¹¹. Cross sections averaged on neutron spectrum from primary ²³⁵U fission, σ_f , for major threshold reactions of NAA interest are available from literature with uncertainties less than 15%¹⁴ (good enough for minor corrections).

Solution – Activation equation, $A_{sp} = (m/M)N_A\theta\epsilon\gamma\phi_f\sigma_f$, can thus be used for calculation of the analytical peak count rates, A_{sp} , contributed by interfering threshold reactions with σ_f from literature and ϕ_f instantly determined using ⁵⁴Fe (n,p) (Fe wire can simultaneously be used as a comparator of k_0 -NAA) or ⁵⁸Ni (n,p) (Ni can simultaneously be used as Ni standard) reactions.

Table 4 Determinations of ϕ_f in Channel B-2 10-20 of MURR¹¹

Reaction	A _{sp}	M	E _γ	γ	ε	θ	σ _f , mb	E _{threshold}	φ _f
²⁴ Mg(n,p)	36500	24.3	1.368	1.00	3.6E-4	0.79	1.53	7.1	3.4E12
²⁷ Al(n,α)	20300	27	1.368	1.00	3.6E-4	1.00	0.73	8.4	3.5E12
⁴⁶ Ti(n,p)	20400	47.9	0.889	1.00	5.5E-4	0.083	10.5	5.4	3.5E12
⁴⁷ Ti(n,p)	108000	47.9	0.158	0.685	3.3E-3	0.075	16.3	3.7	3.1E12
⁴⁸ Ti(n,p)	4700	47.9	0.983	1.00	4.9E-4	0.737	0.27	7.2	3.8E12
⁵⁴ Fe(n,p)	580000	55.8	0.834	1.00	5.8E-4	0.058	82.5	4.4	2.9E12
⁵⁸ Ni(n,p)	1330000	58.7	0.810	0.99	6.1E-4	0.681	113	4.3	2.8E12

$$\text{Av. } \phi_f = (3.29 \pm 0.36)\text{E12}$$

Parametric normalization for full-energy peak efficiencies obtained at different counting positions^{15,16}

Necessity – Very often different counting positions have to be used for samples in the same package to cope with samples/standards with extremely different activities. Existing methods for normalizing the efficiencies from different counting positions (both mathematic and chemical ones) are too complicated for routine use.

Feasibility – According to “Effective Interaction Depth, EID” law, a cylindrical Ge detector can be considered as a point at certain depth (depending on γ -ray energy, E) of the Ge crystal axis. The full energy peak efficiency ε is inversely proportional to the square of the distance from source (point source at the extended line of Ge crystal axis) to that point. In a systematic study, the EID theory was experimentally verified, application scope established (quasi-point source, cascade/crossover free gamma-rays) and uncertainties estimated (< 3%).

Solution - EID as a function of gamma-ray energy, $S_0(E)$, has been established for our HPGe detectors by using Eq. (2) and used in all routine NAA work.

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{(S_0(E) + S_2)^2}{(S_0(E) + S_1)^2} \quad (2)$$

where, $S_0(E)$ = EID measured from an arbitrary base-plane near detector surface, $S_0(E)$ is unique for a given Ge detector; S_1, S_2 = distances from source to that base-plane for counting positions 1 and 2, respectively; $\varepsilon_1, \varepsilon_2$ = full-energy peak efficiencies for γ -rays with energy E at counting positions 1 and 2, respectively. Data shown in Table 5 are an example of experimental verification of EID law.

Table 5 EID prediction for relative efficiencies of a Ge(Li) detector¹⁵

E, keV	S ₁ = 640mm			S ₂ = 320 mm			S ₃ = 80 mm			S ₀ (E), mm
	Pred.	Meas.	Δ, %	Pred.	Meas.	Δ, %	Pred.	Meas.	Δ, %	
121.8	0.0830	0.0829	+0.1	0.301	0.309	-2.6	2.890	2.868	+0.8	34.3
344.3	0.0880	0.0893	-1.5	0.312	0.312	0	2.773	2.717	+0.6	42.5
778.9	0.0895	0.0905	-1.1	0.315	0.315	0	2.691	2.658	+1.2	44.7
964.0	0.0898	0.0898	0	0.316	0.319	-0.9	2.684	2.684	0	45.4
1112.0	0.0903	0.0885	+2.0	0.317	0.314	+1.0	2.669	2.706	+1.4	46.3
1408.0	0.0905	0.0894	+1.2	0.318	0.320	-0.6	2.664	2.726	-2.3	46.6

In addition, the definition of “Total Efficiency, ϵ_T ”, an important parameter in summing effect corrections, is clarified in this work. It is pointed out that the low energy scattering contributions should be included in “total response”, since the flight times of these scattering γ -rays are in the order of ns, compared to μ s of pulse processing time. Thus, ϵ_p/ϵ_T is not an inherent parameter of a Ge detector but related to surroundings, and is not independent of counting position but counting geometry related.

Parametric evaluation and necessary correction for neutron flux self-shielding effects^{17,18}

Necessity – One of the important prerequisites for elemental determinations in NAA is that the unknown samples and standards/ comparators should be irradiated at the same neutron flux and spectrum. Neutron flux self-shielding effect in either or both the samples and standards will violate this precondition and cause error. Traditional ways of corrections for neutron flux self-shielding, such as “extrapolation to zero mass” or “internal standards (spikes)”, are too complicated for routine use.

Feasibility - For minor self-shielding effects, e.g. only a few percent, some established theoretical treatment may be good enough. For larger self-shielding effects, it is suggested to give up INAA and seek for other methods.

Solution – Zweifel equations¹⁹ for foil and cylinder samples were used for estimation and corrections (for the effects of smaller than 10%) for neutron flux self-shielding in INAA of two Chinese multi-metal nodule RMs¹⁷. Gilat equation²⁰ with an improvement in sample shape definition was used for estimation of overall neutron flux self-shielding effects for 250 mg each of USGS BCR-1 and AGV-1 samples¹⁸.

Most of the above functions have been, or are being, incorporated in a hybrid k_0 -relative NAA software, as

part of our automated NAA system²¹.

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Study of the Chromium Metabolism and Speciation in Diabetic Rats by Enriched Stable Isotopic Tracer Technique Combined with Neutron Activation Analysis

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Trivalent chromium (Cr III) has been known as a potentiator to insulin in mammal glucose and lipid metabolism. However, the chromium (III) metabolism and speciation in organisms is still not well known because of its ultra low content exist. In order to study the metabolism of Cr (III) in diabetics, the distribution patterns of chromium in the liver, kidney, pancreas, testes as well as in the organic subcellular fractions of the alloxan-diabetic rats were studied by the enriched stable isotope $^{50}\text{Cr}^{3+}$ tracer technique combined with neutron activation analysis (NAA). Further, the chromium-containing proteins in the liver cytosol, serum and urine of the normal and diabetic rat were investigated. After a single intravenous injection of enriched stable isotope Cr-50 tracer solution, the Sephadex G-25 gel chromatography combined with NAA was used to isolate and characterize protein-bound chromium in the above materials.

Key words: Trivalent chromium (Cr III), enriched stable isotopic tracer technique, neutron activation analysis, metabolism, speciation, rat

Introduction

Chromium (Cr), as a trivalent organic or inorganic form, has been proposed to act as a potentiator of insulin action in animals and human beings. Cr deficiency induces symptoms resembling diabetes, such as glucose intolerance impairment with requirement of increasing insulin, etc, and Cr supplement can alleviate these symptoms^{1,2}.

Nowadays, millions of diabetics are now provided with various kinds of commercial Cr supplements, such as chromium picolinate, chromium-rich yeast and so forth. Unfortunately, up to now, embarrassed by the low level of Cr in individual and animal bodies, little is known about chromium speciation naturally occurring in mammals, as well as its metabolism and biological function. Our previous metabolic experiment³ found that Cr was widely distributed in various organs and tissues of rats. Nevertheless, until now, the only available candidate for Cr substances *in vivo* is the low-molecular-weight, Cr-binding complex (LMWCr), which was extracted from animal liver or cow colostrums⁴⁻⁶. Kaim⁷ once indicated that in the first transition elements from vanadium to zinc, which are essential to some form of life, chromium is the only element for which no one metalloprotein containing it had been well characterized in terms of its function and mode of action. Therefore, there is increasing interest in studying protein-bound Cr complexes and in identifying

their biological, chemical and physiological properties.

Among the Cr speciation researches, different kinds of chemical and biological separation methods are needed. Unfortunately, as the concentration of Cr in many biological materials is usually at ultratrace level (~ng/g), it is almost impossible to avoid the exogenous Cr contamination caused from separation and determination processes. Therefore, the analysis is usually so complicated and difficult that a highly sensitive and accurate analytical method is desirable. Fortunately, using activable enriched stable isotope Cr-50 tracer technique could overcome the above problem. In this paper, $^{50}\text{Cr}_2\text{O}_3$ with 94.2% ^{50}Cr was used as a tracer combined with gel chromatography to study the Cr speciation in normal and diabetic rats. Compared to the 4.35% natural abundance of ^{50}Cr , the elevation of more than 20 times of ^{50}Cr abundance in enriched stable compound could highly improve the sensitivity of the tracer technique. Furthermore, in contrast to the radioactive tracer method, the enriched stable isotope does not introduce radiation damage to the cells. The Cr concentration can be determined via $^{50}\text{Cr}(n, \gamma)^{51}\text{Cr}$ by neutron activation analysis (NAA), which is ideally suited for the ultratrace element analyses due to its high precision, accuracy and sensitivity.

Experimental

$^{50}\text{Cr}(\text{III})$ tracer solution preparation

The enriched stable isotope Cr-50 compound, $^{50}\text{Cr}_2\text{O}_3$, in which the isotopic abundance of ^{50}Cr is 94.2%, was purchased from the Institute of Atomic Energy, Beijing, China. In order to make $^{50}\text{Cr}^{3+}$ solution, $^{50}\text{Cr}_2\text{O}_3$ was first dissolved in a few drops of HClO_4 , then a small amount of 2mol/L HCl and 30% H_2O_2 were added to reduce any Cr(VI) to Cr(III).

Animal treatment

Twelve male Wistar rats, weighing about $150\pm 20\text{g}$, were purchased from the Center of Experimental Animals of Beijing Medical University. The rats were divided into two groups *ad libitum*. One group of rats was given alloxan (Sigma Co.) intravenously to produce diabetic rats, whereas another group was used as control. The detailed method of producing chemically induced diabetic rats was described in our previous paper³.

The two groups of rats were injected intravenously with the above $^{50}\text{Cr}(3+)$ tracer solution every 24h at a dose of $50\mu\text{g Cr}(3+)/100\text{g body wt}$ for 3 successive days. At the 4th day, after collecting the whole blood from the cervical vein, the rats were sacrificed. The liver, kidney, pancreas and testes were immediately collected, washed with deionized water and maintained at -70°C until used.

The urine samples of the two groups of rats were collected separately.

Sample preparation

The tissue samples were washed with a 10mM HEPES/0.25M sucrose buffer (pH=7.5), then cut into strips by a Teflon knife, and homogenized with 4~7 volumes of the buffer in a glass homogenizer. The homogenate was first centrifuged at $50\times g$ for 7 min to remove non-disrupted cell and then the supernatant

was separated into different fractions by successive differential centrifugation to get nuclei, mitochondrion, lysosome, microsome and cytosol.

Gel chromatography on Sephadex G-25

10ml cytosolic solution obtained from the two group rats was subjected to a Sephadex G-25 column ($\phi 1.6 \times 60$ cm) separation.

The serum samples collected from the same group rats were mixed together. 14.6ml from the normal rat and 8.6ml from the diabetic rat were used to the gel separation, respectively.

15ml of urine samples of the normal and diabetic rats were applied to the column.

The 0.1M $\text{CH}_3\text{COONH}_4$ buffer (pH=6.60) solution was used for the column equilibration and samples elution. The flow rate of elution was 19ml/h. Each fraction of 4ml/ tube was collected.

Chromium determination

All the reagents that were used were of the highest available purity. The deionized water was used throughout. Glassware was soaked in 1:1 nitric acid for over 1 week and rinsed thoroughly with deionized water before use.

The tissue samples were freeze dried. The subcellular and the eluted fraction samples were dried under an infrared lamp. All the biological samples were covered by Teflon film and aluminum foil. The samples and the standards were irradiated in the Institute of Atomic Energy's swimming pool reactor at a flux of $2 \times 10^{13} \text{ n/cm}^2 \cdot \text{s}$ for 24h. After 2 weeks decay, the ^{51}Cr radioactivity was counted by a high pure Ge detector with PC-based Ortec MCA.

Results

Blanks and reference materials

All the reagents used in this paper were of the G.R. or A. R. purity. Glassware was soaked in 8mol/l nitric acid for 1 week and rinsed thoroughly with deionized water before use.

The blanks of the reagents and all the package materials for irradiation were analyzed by NAA. The results indicated that no detectable Cr contamination in the whole procedure was found or the Cr content in the blanks compared to that in the samples was negligible.

A number of standard reference materials: Bovine Liver (NIST 1577a), Pork Liver (GBW 08551), Shrub Leaves (GBW 07602) and Poplar Leaves (GBW 07604) were analyzed for evaluating the accuracy of INAA. The results are shown in Table 1. The agreement between our values and the certified values is quite well, confirming the good accuracy and precision of our procedures.

Table 1. Cr contents in standard reference materials by INAA ($\mu\text{g/g}$)

SRM	This work	Certified value
Bovine Liver (NIST 1577a)	0.23 ± 0.07	0.2 ± 0.1 ⁸
Pork Liver (GBW 08551)	0.16 ± 0.03	$(0.2)^*$ ⁹
Shrub Leaves (GBW 07602)	0.55 ± 0.04	0.55 ± 0.05 ⁹
Poplar Leaves (GBW 07604)	2.1 ± 0.1	2.3 ± 0.2 ⁹

* Reference value. The number of determination is 6.

Table 2. Chromium contents in subcellular fractions of rat liver

Subcellular Fractions	Cr Concentration $\mu\text{g/g}$		In Total Cell %		Cr/Total Protein ^a $\mu\text{g/g}$	
	N	D	N	D	N	D
Homogenate	0.42 ± 0.06	0.31 ± 0.09	—	—	1.96 ± 0.16	2.14 ± 0.16
Residue	0.59 ± 0.17	0.50 ± 0.20	21.5	11.7	1.57 ± 0.17	1.95 ± 0.20
Nuclei	2.01 ± 0.42	1.69 ± 0.26	27.0	33.3	5.14 ± 0.42	4.14 ± 0.26
Mitochondria	0.99 ± 0.23	1.39 ± 0.19	18.2	18.7	3.58 ± 0.23	5.87 ± 0.21
Lysosome	0.59 ± 0.17	0.55 ± 0.21	5.14	6.72	1.43 ± 0.18	2.87 ± 0.21
Microsome	0.11 ± 0.01	0.61 ± 0.15	0.883	10.9	0.29 ± 0.01	4.08 ± 0.15
Cytosol	0.13 ± 0.04	0.12 ± 0.05	27.3	18.8	1.98 ± 0.13	1.54 ± 0.05

^a Cr/protein means the ratio of the amount of Cr to the total quantity of protein in the fraction. The meanings are the same in the following tables.

Values are expressed as mean \pm SD (N=6).

N—Normal rats, D—Diabetic rats.

Table 3. Chromium contents in subcellular fractions of rat pancreas

Subcellular Fractions	Cr Concentration $\mu\text{g/g}$		In Total Cell %		Cr/Total Protein $\mu\text{g/g}$	
	N	D	N	D	N	D
Homogenate	0.151 ± 0.010	0.079 ± 0.006	—	—	1.33 ± 0.11	0.78 ± 0.07
Residue	0.081 ± 0.006	0.143 ± 0.004	4.82	5.66	0.94 ± 0.08	0.82 ± 0.05
Nuclei	0.116 ± 0.007	0.132 ± 0.004	4.36	6.79	0.85 ± 0.07	0.33 ± 0.02
Mitochondria	0.252 ± 0.010	0.174 ± 0.009	7.24	6.79	1.24 ± 0.08	0.25 ± 0.02
Lysosome	0.308 ± 0.008	0.161 ± 0.009	3.50	4.98	1.08 ± 0.06	0.54 ± 0.04
Microsome	0.246 ± 0.009	0.128 ± 0.008	9.49	7.20	1.75 ± 0.11	0.48 ± 0.04
Cytosol	0.158 ± 0.004	0.119 ± 0.004	70.6	68.4	2.31 ± 0.13	1.08 ± 0.07

Notes: The pancreas of 6 rats were homogenized together and then separated into subcellular fractions. The chromium measurement error is less than 5%.

N—Normal rats, D—Diabetic rats.

Table 4. Chromium contents in subcellular fractions of rat testis

Subcellular Fractions	Cr Concentration $\mu\text{g/g}$		In Total Cell %		Cr/Total Protein $\mu\text{g/g}$	
	N	D	N	D	N	D
Homogenate	0.21 \pm 0.01	0.12 \pm 0.01	—	—	2.66 \pm 0.18	1.52 \pm 0.11
Residue	0.46 \pm 0.01	0.19 \pm 0.01	8.56	10.9	1.32 \pm 0.07	3.48 \pm 0.26
Nuclei	0.45 \pm 0.01	0.22 \pm 0.01	14.7	11.7	2.99 \pm 0.17	1.08 \pm 0.07
Mitochondria	0.63 \pm 0.01	0.36 \pm 0.01	8.03	8.50	2.06 \pm 0.11	1.10 \pm 0.06
Lysosome	0.58 \pm 0.01	0.34 \pm 0.01	3.68	3.89	1.50 \pm 0.08	0.87 \pm 0.05
Microsome	0.41 \pm 0.01	0.20 \pm 0.01	2.87	3.26	1.23 \pm 0.07	0.74 \pm 0.05
Cytosol	0.32 \pm 0.01	0.12 \pm 0.01	62.2	61.8	3.59 \pm 0.18	1.72 \pm 0.14

Notes: The pancreas of 6 rats were homogenized together and then separated into subcellular fractions. The chromium measurement error is less than 5%.

N—Normal rats, D—Diabetic rats.

Table 5. Chromium contents in subcellular fractions of rat kidney

Subcellular Fractions	Cr Concentration $\mu\text{g/g}$		In Total Cell %		Cr/Total Protein $\mu\text{g/g}$	
	N	D	N	D	N	D
Homogenate	1.28 \pm 0.01	1.09 \pm 0.01	—	—	6.25 \pm 0.32	4.76 \pm 0.24
Residue	1.81 \pm 0.02	1.01 \pm 0.01	6.57	8.40	3.84 \pm 0.20	3.16 \pm 0.16
Nuclei	1.65 \pm 0.02	1.17 \pm 0.01	15.6	19.4	3.95 \pm 0.20	3.18 \pm 0.16
Mitochondria	2.00 \pm 0.02	1.55 \pm 0.02	12.7	8.64	5.95 \pm 0.31	4.52 \pm 0.23
Lysosome	1.80 \pm 0.02	1.53 \pm 0.02	6.96	6.91	7.73 \pm 0.40	5.75 \pm 0.30
Microsome	1.35 \pm 0.02	0.98 \pm 0.01	2.81	3.00	4.08 \pm 0.21	3.14 \pm 0.16
Cytosol	0.72 \pm 0.01	0.55 \pm 0.01	55.4	53.6	8.36 \pm 0.43	6.54 \pm 0.34

Notes: The kidney of 6 rats were homogenized together and then separated into subcellular fractions.

The chromium measurement error is less than 5%.

N—Normal rats, D—Diabetic rat.

Chromium in subcellular fractions of rat liver, pancreas, kidney and testes

The chromium contents in subcellular fractions of normal and diabetic rat liver, pancreas, testes and kidney are given in Table 2-5.

The liver homogenate of the normal rats has slightly higher Cr content than the diabetic. In the subcellular distribution the nuclei fraction contains the highest Cr values among all the fractions of both group rats. The Cr contents in various cell fractions of the normal rats decrease in the following order: nuclei > mitochondria > lysosome > cytosol \approx microsome, whereas for the diabetic rats, it decreases in the order: nuclei > mitochondria > microsome \approx lysosome > cytosol. Comparatively, Cr is mainly enriched in the

nuclei, mitochondrial and cytosol fractions. However, the Cr contents in the mitochondrial and microsomal fractions of the diabetic rats are significantly higher than those of the normal rats ($p < 0.001$). When expressed as Cr/protein, the Cr contents in the mitochondrial, lysosomal and microsomal fractions of the diabetic rats is statistically higher than those of the normal rats ($p < 0.001$).

Table 3 shows that the Cr content in the pancreatic homogenate of the normal rats is twice as that of the diabetic rats. In the intracellular distribution, the Cr contents in the fractions of the normal rats are statistically higher than those of the diabetic rats ($p < 0.05$), except in the nuclei fraction. Cr content in nuclei is similar in both groups. In the relative percentage distribution, about 68~70% Cr is accumulated in the cytosol fraction. The Cr distribution pattern in the pancreas subcellular fractions is not statistically different in the two group rats. The Cr/protein ratios in the sub-fractions of the diabetic rats are 1~4 times lower than those of the normal rats.

There is still statistically higher Cr content in the testes homogenate of the normal rats than of the diabetic rats ($p < 0.001$), and so is in the subcellular fractions ($p < 0.05$). The intracellular results show the higher Cr/protein values in the normal rats than in the diabetic rats as well. The cytosol has the highest value for Cr, while the rest Cr is mainly contained in nuclei and mitochondria.

The Cr distribution pattern, either in the homogenate or in the subcellular fractions in kidney of the two group rats, is not much different from its pattern in pancreas and testes. Cr contents in the subcellular fractions of kidney of the normal rats are somewhat higher than those of the diabetic rats, and so are also the results expressed as Cr/protein. Almost 53~55% of total Cr is accumulated in cytosol, while the rest is retained in the nuclei and mitochondrial fractions.

Gel filtration patterns of Cr in liver cytosol

Fig. 1 shows that Sephadex G-25 gel filtration spectrum of Cr in liver cytosol of the normal rat is similar to that of the diabetic, but the former contains much higher Cr than the latter. There are two significant Cr eluted peaks in the fractions that correspond to the ultraviolet absorbance at 280nm. Although the second lower Cr peak's ultraviolet absorbance is not significant as shown in Fig. 1, which is probably due to the low Cr and protein content in the peak, it indeed contains protein verified by both VIS-UV spectrum determination and protein concentration analysis (data not shown here). The first higher peak (I), just in the eluted position of Blue Dextran, represents a great amount of high-molecular-weight compounds in the liver cytosol. Peak I contains 59.8% of Cr comparing to the total eluted Cr in the normal rat liver cytosol. Similarly, in the diabetic rat, it is 58.2%. The second Cr peak (II) was eluted near the void volume of

the column, whose maximum ultraviolet absorbance was at 260nm. On the contrary to peak I, peak II is primarily composed of low-molecular-weight compounds, which contains 26.9% and 36.8% of the total Cr in the normal and diabetic rat, respectively. The rest amount of Cr conjecturally exists as inorganic salts or was combined with amino acids and small peptides, etc. in the elution volume after 200ml of the column.

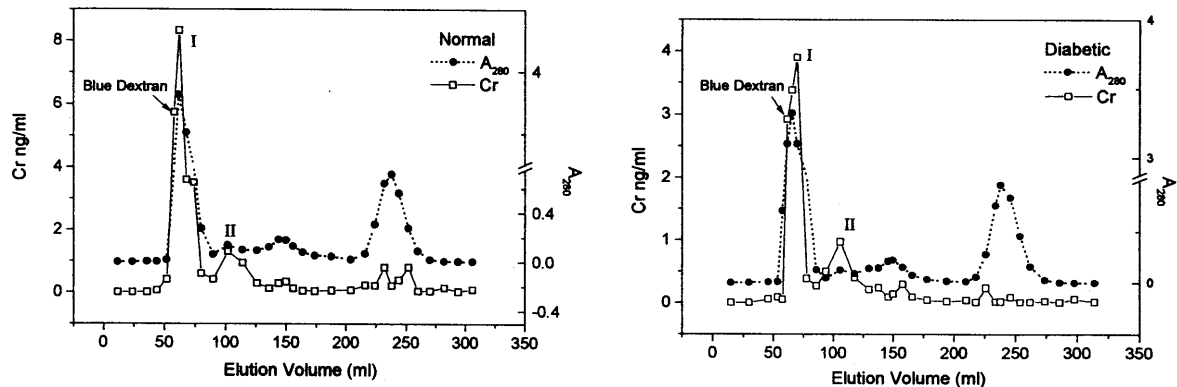


Fig. 1. Sephadex G-25 chromatography of the liver cytosol of the normal and diabetic rat

Gel filtration pattern of Cr in serum

The serum chromatographic pattern of the normal rat is almost the same as of the diabetic, except for the different Cr concentration (Fig. 2). Furthermore, the gel filtration pattern of Cr in serum is similar to that in the liver cytosol. A major portion of Cr in serum was observed in the Blue Dextran position of the Sephadex G-25 gel chromatography with the ultraviolet absorbance at 280nm as in the liver cytosol. Approximately, 90.3% of the total Cr exists in this fraction of the normal rat and 89.1% of the diabetic rat. Comparing to the liver cytosol gel chromatography, a significant protein peak was eluted at the volume from 100 to 130ml. The maximum ultraviolet absorbance of its corresponding Cr peak is also at 260nm. The percentage of total Cr in this peak is not much different between the normal and diabetic rats, i. e. 8.2% and 10.2%, respectively.

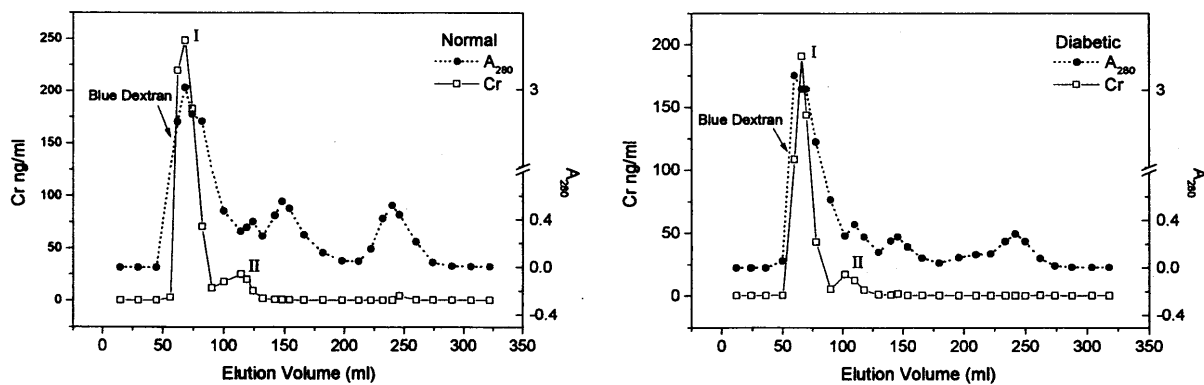


Fig. 2. Sephadex G-25 chromatography of serum of the normal and diabetic rat

Gel filtration pattern of Cr in urine

Urine is the channel of several metabolites excreted from kidney. It is chiefly composed of low molecular weight components, e. g. urea, uric acid, creatinine, inorganic ions and water, etc. When the urine samples of both normal and diabetic rats were subjected to the Sephadex G-25 column and eluted with 0.1M $\text{CH}_3\text{COONH}_4$ buffer (pH=6.60), as contrast to the patterns of liver cytosol and serum, only a single Cr peak was eluted near the void volume of the column. The peak possesses the same properties of peak II as shown in Figs.1 and 2 that was eluted at the same position of the column and has the maximum ultraviolet absorbance at 260nm.

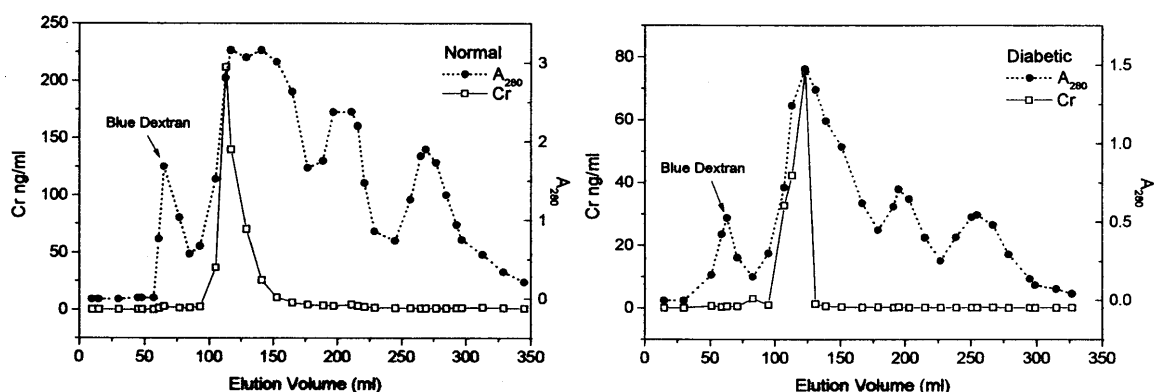


Fig. 3. Sephadex G-25 chromatography of urine of the normal and diabetic rat

Discussion

Our results show evident differences of Cr distribution in various organs and subcellular fractions between the normal and diabetic rats, though their Cr treatment is the same.

Our previous study ^[3] indicated that diabetic rats contained less Cr in their bodies than did normal rats, because of their higher Cr excretion amounts in the urine. In this study, the analysis of Cr contents in the liver, kidney, pancreas and testes of the two group rats again reconfirmed our previous results.

The Cr contents in the liver cytosol and serum samples of the normal rats are higher than those in the diabetic. In this experiment, the total urine quantity of the diabetic is approx. 14 times larger than the normal. Therefore, the diabetic rats characteristic of the polyuria actually excrete much more amount of Cr than the normal rats, though the urine Cr concentration of the diabetic rats is lower than the normal. The above results are all in accordance with that of our previous metabolic experiment ³.

The Sephadex gel chromatography of liver cytosol, serum and urine of rats revealed a similar low-molecular-weight, Cr-containing compound in the same fraction of elutes. Chromium is excreted chiefly as LMWCr in urine. These findings are in substantial agreement with the results of other researches ^{5, 10}. Nevertheless, In this study, we found that Cr(III) was mainly combined with a high-molecular-weight protein either in liver cytosol or in serum of both normal and diabetic rats.

Acknowledgments

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Preliminary Studies on Determination of Trace Platinum in Airborne Particulate Matter by Instrumental Neutron Activation Analysis

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The interferences in determination of trace Pt in airborne particulate matter by instrumental neutron activation analysis were preliminary studied. The mathematical correction method was used to correct the interference contribution of Ca in Pt determination. The result of this study shows that the mathematical correction method is reliable.

Key words Neutron activation analysis, Platinum, airborne particulate matter

Introduction

Element platinum plays a decisive role in the performance of exhaust systems, worldwide applied in vehicles, to reduce the emission of gaseous pollutants such as carbon monoxide, nitrogen oxides and hydrocarbons [1,2]. However, the hot exhaust gases flowing through the catalytic converter cause abrasion and ablation of these units, leading to the emission of the Pt to the environment. Thus, the novel anthropogenic metal has an increasing impact on nature due to the increasing number of cars equipped with catalytic converters [2]. Moreover, several platinum group elements (PGEs) and their complex salts (e.g. Pt- and Pd-chlorides) have been reported as potential health risks to human, causing asthma, allergy, rhino-conjunctivitis and other serious health problems [3,4]. No data are as yet available about inhalation exposure, nevertheless, several observations identify a possible danger by inhalation [5,6,7].

The environmental impact of the PGEs is obvious. Several investigations found that Pt concentrations in remote snow cores of Greenland and the Alps have been considerably rising since 1975, and had increased 40-fold until the mid-1990s [8,9]. The Pt/Rh ratio was found to be very close to that in catalytic converters [9]. The PGEs polluted places are located at high altitude and far away from residential areas of heavy traffic, indicating a large-scale contamination impact of the vehicle catalysts, likely through the troposphere of the Northern Hemisphere [8].

Considering the facts mentioned above, the monitoring of Pt derived from the emission of automotive catalytic converters attrition into environmental samples has very importance with respect to estimation of

the future risk of the human health and ecosystem. The monitoring the Pt concentrations is part of the environmental and health programmes of the IAEA and the WHO [7]. PGEs are among the least abundance elements in the Earth's crust, and natural PGEs in airborne particulate matter are therefore expected to be low. Although emissions of Pt from automobile catalysts have resulted in elevated concentrations of Pt in the urban air, the concentrations of Pt is still relatively low. Thus, the analysis of Pt in airborne particulate matter is challenging. At present, the analytical technique widely applied for the determination of PGEs in airborne particulate matter is inductively coupled plasma mass spectrometry (ICP-MS) [10].

Instrumental neutron activation analysis (INAA) is a high sensitive method for the determination of PGEs. An outstanding merit of INAA over ICP-MS is without acid digestion of samples, any pre-concentration and/or separation of the analyte/matrix. Alfassi and co-workers developed a method of INAA for the determination of Pt by the ^{199}Au daughter of ^{199}Pt [11]. In the method, a mathematical correction method was used to correct interference from ^{47}Sc daughter of ^{47}Ca . In the studies of Alfassi and co-workers, however, only the standards with Pt amounts in the μg range and the concentration ratio of Ca/Pt in $10^3\sim 10^4$ level were analyzed to demonstrate the reliability of the method. In the airborne particulate matter of shanghai, the concentration ratio of Ca/Pt is about $10^5\sim 10^6$ level and the Pt amounts is in the ng range in filter samples. In this study, the method of INAA was used for the determination of Pt. The standards not only with Pt amounts in the μg range and the concentration ratio of Ca/Pt in $10^3\sim 10^4$ level but also with Pt amounts in the ng range and the concentration ratio of Ca/Pt in 10^6 level were analyzed to demonstrate the reliability of the method.

Methodology

There are four radionuclides that can be used for determination of Pt by INAA (Table 1). The 538.9 keV γ -ray of ^{191}Pt is recommended by the IAEA because it is free spectral interferences. But the ^{191}Pt suffers from low sensitivity in most of the environmental samples due to low natural abundance (0.01%). The INAA of ^{199}Pt is limited because of its short half-life of 30.8 min. Thus, Pt is often determined via ^{197}Pt or via the ^{199}Au daughter of ^{199}Pt . In airborne particulate matter sodium is a matrix component. The intense Compton-scattering background originating from ^{24}Na hinders the counting of the main γ -ray of ^{197}Pt at 77.4 keV, because the half-life of ^{197}Pt is close to that of ^{24}Na ($t_{1/2}=14.96$ h). Thus, the INAA of ^{197}Pt is limited for analysis of airborne particulate matter. In addition, the γ -ray of ^{197}Pt at 77.4 keV will be interfered from ^{197}Hg . The ^{199}Au is daughter of ^{199}Pt via ^{198}Pt . The determination Pt by the main γ -ray of ^{199}Au at 158.4 keV is very sensitive due to appropriate half-life, high peak intensity and larger effective cross section (Table 1). For the

determination of Pt by ^{199}Au there is a nuclear interference from the double neutron capture of ^{197}Au . The interference can be corrected by irradiating Au chemical standards together with samples.

Table 1. Nuclear data for the radionuclides in determination of Pt by INAA

Daughter nuclide	^{191}Pt	^{197}Pt	^{199}Pt	^{199}Au
Mother nuclide (nat. abund. In %)	^{190}Pt (0.01)	^{196}Pt (25.3)	^{198}Pt (7.2)	^{199}Pt
Half-life	2.8 d	18.3 h	30.8 min	3.319 d
Main γ -ray energy [keV] (peak intensities %)	538.9(13.4) 409.0(7.9)	77.4(20) 191.4(5.7)	543.0(16.4) 493.5(6.2)	158.4(76.8) 208.2(16.6)
Effective cross section (b)	0.015	0.55	3.8	3.8

However, there are some γ spectral interferences for the determination Pt by 158.4 keV of ^{199}Au (Table 2). The interferences of ^{47}Sc originating from the (n, p) reaction of ^{47}Ti and the (n, α) of ^{50}V can be neglected by the selection of thermal position in reactor. Also, radionuclide ^{47}Sc is produced by the double neutron capture of ^{45}Sc . Scandium is a trace component in airborne particles and the formation probability of the ^{47}Sc in reactor under the irradiation time of about 8 h is very low due to the long half-life of ^{46}Sc ($t_{1/2}=83.8$ d). Thus, the interference of the ^{47}Sc originating from the double neutron capture of ^{45}Sc can be ignored. The γ spectral interference from $^{123\text{m}}\text{Te}$ can be neglected because tellurium is a trace element in airborne particulate matter and the formation probability of $^{123\text{m}}\text{Te}$ in reactor under the irradiation time of about 8 h is very low due to the long half-life of $^{123\text{m}}\text{Te}$ ($t_{1/2}=119.7$ d). For the determination Pt by 158.4 keV of ^{199}Au , a spectral interference might arise from calcium because calcium is a major component in airborne particulate matter. The spectral interference of ^{47}Sc caused by ^{46}Ca (n, γ) ^{47}Ca reaction followed by β^- decay should be corrected for the determination of Pt by 158.4 keV of ^{199}Au . In this study, the mathematical correction method was used to correct the interference contribution of Ca in Pt determination.

The integral counts of 159 keV peak and 1297 keV peak are given by two equations as follows [11]:

$$\text{Counts}_{159} = a_1 \times m_{Ca} \times f_1(t_i, t_d, t_c) + a_2 \times m_{Pt} \times f_2(t_i, t_d, t_c) \quad (1)$$

$$\text{Counts}_{1297} = a_3 \times m_{Ca} \times f_3(t_i, t_d, t_c) \quad (2)$$

Where m_{Ca} is the amount of calcium (mg), m_{Pt} is the amount of platinum (mg), a_1 , a_2 and a_3 are constants dependent on the flux and the neutron spectrum in the reactor, the probability of formation, the

intensities of the γ -rays, and the detection efficiency of detector. f_1, f_2 and f_3 are functions of the irradiation time (t_i), cold time (t_d) and counting time (t_c).

Table 2. Spectral interferences for the determination Pt by 158.4 keV of ^{199}Au

Elements	Nuclear reactions	Abundance (%)	Cross section (b)	Half-life (d)	γ -Ray (keV)
Ti	$^{47}\text{Ti}(n, p)^{47}\text{Sc}$	7.5	20	3.41	159.4
V	$^{50}\text{V}(n, \alpha)^{47}\text{Sc}$	0.25	1.5	3.41	159.4
Ca	$^{46}\text{Ca}(n, r)^{47}\text{Ca}(\beta^-)^{47}\text{Sc}$	0.0033	0.7	4.54, 3.41	159.4
Sc	$^{45}\text{Sc}(n, r)^{46}\text{Sc}(n, r)^{47}\text{Sc}$	100	16.9, 8	83.8, 3.41	159.4
Te	$^{123}\text{Te}(n, r)^{123\text{m}}\text{Te}$	2.46	1	119.7	159.0

By the equations (1) and (2), the m_{Pt} and m_{Ca} are obtained by the equations [11]:

$$m_{\text{Ca}} = \frac{a_3 \times f_3}{\text{Counts}_{1297}} \quad (3)$$

$$m_{\text{Pt}} = \left(\frac{\text{counts}_{159} \times f_3}{\text{counts}_{1297} \times f_1} - a_4 \right) \times \frac{f_1 \times \text{counts}_{1297}}{f_2 \times f_3 \times a_2} \quad (4)$$

Where a_4 is a_1/a_3 .

Experimental

Preparation of standards

There is no commercially available reference material for Pt determination in airborne particulate matter. Thus, mixing standards containing platinum in μg and ng amounts and calcium in mg amounts were prepared for test the method of INAA for the determination of Pt via the ^{199}Au . The high pure CaO powder was used for Ca standard, which was made in Chinese Chemical Industries, Ltd. Certified SPEX mono-element standard solution of Pt (1000 $\mu\text{g}/\text{mL}$, SPEX CertiPrep INC.) was used as original standard solutions to prepare Pt working solution. The mixing standards were prepared as follows: Different amounts of CaO were weighed and placed onto a filter paper (square-shaped, 2 cm \times 2 cm). The Pt working solution was pipetted to the CaO powder. After drying, the filter containing the CaO powder was folded into a small and thin square for INAA. Meanwhile, analytical standards of Ca and Pt were prepared by the CaO powder

and Pt working solution.

Irradiation and Counting

Irradiations were performed in the research reactor of the Chinese Academy of Atomic Sciences. The neutron flux was $4.83 \times 10^{13} \text{ n s}^{-1} \text{ cm}^{-2}$. The irradiation time was 8 h. Counting the activated samples after the irradiations was done at the Nuclear Analysis Laboratory of Institute of High Energy Physics, Chinese Academy of Sciences. The HPGe detectors with the relative efficiency of 35% and the energy resolution of 1.70 keV (FWHM, at 1330 keV γ -ray), connected to Ortec multi-channel analyzers, were applied to the counting. Samples were counted 5000-10000 seconds after cooling for one week.

Results and discussion

The concentrations of calcium and platinum in all the standards were computed according to the equations (3) and (4), respectively (Tables 3 and 4). For the standards with Pt amounts in the μg range and the concentration ratio of Ca/Pt in $1 \times 10^3 \sim 3 \times 10^3$ level, results and standard values were in good agreement, which the relative error was in range of $\pm 5.5\%$ (Table 3). The result is consistent with that of Alfassi and co-workers [11].

Table 3. Comparison of actual and calculated amounts of Ca and Pt in the standards with the ratio of Ca/Pt in $1 \times 10^3 \sim 3 \times 10^3$ level and Pt amounts in the μg range

Sample	Ca standard Value (mg)	Calculated Ca amount (mg)	Relative error (%)	Pt standard value (μg)	Calculated Pt amount (μg)	Relative error (%)
7	11.29	11.19	-0.9	10	10.1	0.64
8	19.61	20.01	2.0	10	9.46	-5.36
9	30.40	30.12	-0.9	10	9.67	-3.32

In the airborne particulate matter of shanghai, the concentration ratio of Ca/Pt is about $10^5 \sim 10^6$ level and the Pt amounts is in the ng range in filter samples. Therefore, the standards whose concentration ratio of Ca/Pt and Pt amounts are close to the actual air samples were analyzed. Results were agreement with standard values (Table 4), which the relative error was in range of $\pm 15\%$, indicating that the mathematical correction of the interference from ^{47}Sc daughter of ^{47}Ca is reliable. However, it is noticeable that the

calculated Pt amount is lower than the Pt standard value for three standards with the higher ratio of Ca/Pt and lower Pt amount (Table 4). This might suggest that there is a systematic error in determination of constants a_1 , a_2 and a_3 in the equation (3).

Table 4. Comparison of actual and calculated amounts of Ca and Pt in the standards with the ratio of Ca/Pt in 1×10^6 level and Pt amounts in the ng range

Sample	Ca standard Value (mg)	Calculated Ca amount (mg)	Relative error (%)	Pt standard value (ng)	Calculated Pt amount (ng)	Relative error (%)
24	0.786	0.872	11.0	1.00	0.85	-15
25	1.158	1.265	9.3	1.00	0.89	-11
26	1.701	1.622	-4.6	1.00	0.86	-14

This study is preliminary. In order to apply the method of INAA for the determination of Pt in airborne particulate matter, more investigations are required in further study.

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Study of Organohalogens in Yogurt and Apple by Neutron Activation

Analysis and Related Techniques

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Twenty brands of Chinese commercial yogurt specimens and nine different kinds of apple samples collected randomly from supermarkets of Beijing and Shenzhen, China, were analyzed by instrumental neutron activation analysis (INAA) combined with gas chromatography (GC) and chemical separation methods for total halogens, extractable organohalogens (EOX) and extractable persistent organohalogens (EPOX). The INAA detection limits are 50, 8 and 3.5 ng for Cl, Br and I, respectively. The concentrations and distributions of organohalogens in yogurt and apple samples were determined. The extractable organochlorines (EOCl) accounted for 0.005 to 0.043 % of the total chlorine in yogurt and 1.6 to 5.1 % in apple, also, about 24 % of EOCl survived as the extractable persistent organochlorines (EPOCl) after treatment with concentrated sulfuric acid in yogurt, and 34 % in apple, which indicated that chlorine in the two selected foodstuffs mainly exists as inorganic species and non-extractable organochlorines, and most EOCl in yogurt and apple were acid-labile or acid-soluble fractions. The identified organochlorines (the sum of OCP such as HCHs, DDTs, Chlordanes, heptachlor and PCB such as 52, 60, 103, 105, 128, 143, 154, 173, 182, 202, 205, 207, 208, 209 determined by GC expressed as chlorine) to total EPOCl were 0.7 to 13.1 % and 0.5 to 6.2 % in yogurt and apple samples, respectively, which implied that a major portion of EPOCl measured in yogurt and apple remained uncharacterized.

Introduction

Organic halogens, especially persistent organic pollutants (POPs), such as organochlorine pesticides (OCP) and polychlorinated biphenyls (PCB), have long been recognized as a potential threat to human health and, therefore, these compounds have been widely investigated in foodstuffs [1,2], vegetation [3,4], and the atmosphere [5,6]. Recently, interest in using extractable organohalogens (EOX) as parameters for the quantification of total organohalogen content in sediment [7], biota [8], and water [9] has dramatically increased. However, there is growing evidence that traditional analytical methods such as gas

chromatography (GC) and GC-mass spectrometry (GC-MS) could only provide information about the known POPs, which usually contributed to less than 20 % of total amount of extractable organochlorines (EOCl) in samples. Therefore, the results could not reflect the actual POPs contamination levels [10,11]. Instrumental neutron activation analysis (INAA) is a very convenient and quick method for halogen analysis, and is also the only analytical method currently available for simultaneously determining EOCl, extractable organobromines (EOBr) and extractable organoiodines (EOI) in an extract [7,8,12].

Currently, yogurt and apple are considered as a main component in Chinese diet, because of their certain health benefits and taste. Since POPs can be accumulated in organisms through the food chain, the foodstuffs are not only POPs indicators of the environments, but also the major POPs sources entering the human bodies, thereby causing serious health problems [13]. Thus, monitoring contaminant levels in foodstuffs are imperative for quantifying dietary exposure to POPs. However, little information is available in literature about the concentrations of EOX, EPOX in foodstuffs.

Materials and methods

Sample collection and preparation

Twenty brands of Chinese commercial yogurt specimens and nine different kinds of apple samples were collected randomly from supermarkets of Beijing and Shenzhen, China, from December 2002 to February 2004. 8 to 10 cups for each brand of yogurt and about 1000 g for each kind of apple were treated as soon as they were brought back to laboratory. Same brand yogurt samples were pooled in petri dishes and freeze-dried until constant weight; same kind apple specimens were cut into slices before lyophilizing. The lyophilized sample was stored in a brown glass bottle at -4 °C for use.

Chemicals

Reagents and solvents were at least of analytical grade. Details of their preparation were described elsewhere [1]. The quantitative standards of OCP (α -, β -, γ -, and δ -HCH, *cis*-chlordane, *trans*-chlordane, aldrin, *p,p'*-DDE, *p,p'*-DDD and *p,p'*-DDT), PCB (52, 60, 103, 105, 128, 143, 154, 173, 182, 202, 205, 207, 208, and 209) were purchased from Sulpelco (Bellefonte, PA, USA). The standard solutions of OCP and PCB were prepared by gradually diluting the original solutions of OCP and PCB in distilled n to hexane, respectively. The Cl, Br and I standards were prepared by dissolving the appropriate amount of KCl, KBr and KI (guaranteed reagent grade, content > 99.99 %) in ultrapure water (about 1.0, 0.50 and 0.50 $\mu\text{g}/\text{ml}$ for Cl, Br and I, respectively).

Analysis

Extraction and cleanup. The entire experimental procedure, outlined in Figure 1, is based on a combination of INAA and GC with chemical separation [1,14].

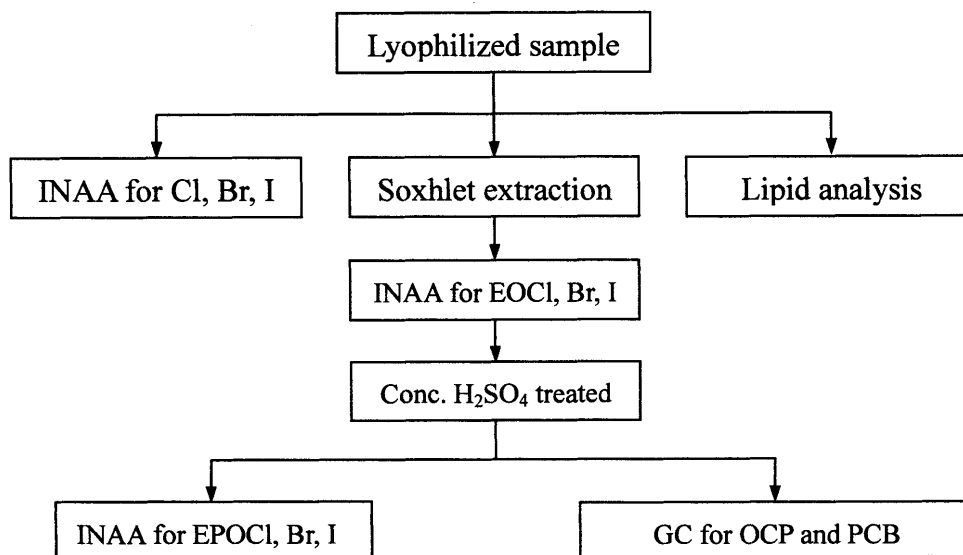


Figure 1. Flow chart for analysis of organohalogenes in yogurt and apple samples by a combination of INAA, GC and chemical separation.

Analysis of total halogens, EOX and EPOX. The concentrations of total halogens, EOX and EPOX in yogurt and apple samples, expressed as chlorine, bromine and iodine, were measured by INAA according to the methods reported by Xu et al. [14]. The γ -energy spectra were measured with a high-purity germanium detector with associated electronics interfaced to a computer to controlled multichannel analyzer (EG&G Ortec, Oak Ridge, TN, USA) for peak area calculations. INAA was carried out at a neutron flux of $8.0 \times 10^{11} \text{ n}\cdot\text{cm}^{-2}\cdot\text{s}^{-1}$. Analyses were based on γ -peaks from ^{38}Cl ($t_{1/2} = 37.24 \text{ min}$, $E_{\gamma} = 1642 \text{ keV}$), ^{80}Br ($t_{1/2} = 17.68 \text{ min}$, $E_{\gamma} = 617 \text{ keV}$) and ^{128}I ($t_{1/2} = 24.99 \text{ min}$, $E_{\gamma} = 443 \text{ keV}$). The quantitative results were calculated by the relative method. The detection limits were 50, 8 and 3.5 ng for Cl, Br and I, respectively. ^{24}Na ($t_{1/2} = 15.0 \text{ h}$, $E_{\gamma} = 2754 \text{ keV}$) was simultaneously determined as a check for contamination caused by inorganic halogens [15].

Analyses OCP and PCB. The GC analyses were carried out by a Varian 3800 gas chromatograph equipped with a ^{63}Ni electron capture detector, using a fused silica capillary column (CP-Sil 5 CB Low Bleed/MS 30 m \times 0.25 mm i.d., with 0.25 μm film thickness). The temperature program was 130 $^{\circ}\text{C}$ for 1 min, increased at 10 $^{\circ}\text{C}/\text{min}$ to 200 $^{\circ}\text{C}$, increased at 3 $^{\circ}\text{C}/\text{min}$ to 230 $^{\circ}\text{C}$, increased at 10 $^{\circ}\text{C}/\text{min}$ to 270 $^{\circ}\text{C}$, and held for 7 min. Injector temperature was 270 $^{\circ}\text{C}$ and detector temperature was 300 $^{\circ}\text{C}$. Helium and oxygen to free nitrogen (99.999 %) were used as carrier and makeup gas, respectively. Peak identification was

conducted by comparing the GC retention time with those of authentic standards, and quantification of OCP and PCB were made by external standard method calibrated with a 5-point calibration curve encompassing the entire concentration range. The detection limits, on the basis of a signal-to-noise ratio of 3:1, were between 0.01 to 0.06 and 0.002 to 0.06 $\mu\text{g}/\text{kg}$ for OCP and PCB standards, respectively; low enough to determine the selected OCP and PCB residues at the required levels in this study.

Lipid analysis. The lipid contents in the yogurt and apple samples were determined by hydrochloric acid hydrolyzation according to the National Standard Method GB5009.6-85 [16].

Results and discussion

The concentrations of the total halogens, EOX and EPOX in twenty brands of Chinese commercial yogurt specimens and nine different kinds of apple samples determined by INAA are listed in Table 1. The concentrations of the total halogens in yogurt and apple samples were both in the order of $\text{Cl} \gg \text{Br} > \text{I}$, which was in agreement with the abundances of Cl, Br and I in nature. EOCl accounted for 0.005 to 0.043 % of the total chlorine in yogurt, and 1.6 to 5.1 % in apple; about 24 % of EOCl survived as the extractable persistent organochlorines (EPOCl) after treatment with concentrated sulfuric acid in yogurt, and 34 % in apple, which indicated that chlorine in both yogurt and apple mainly existed as inorganic species and non-extractable organochlorines, and most EOCl in the two foodstuffs were acid-labile or acid-soluble fractions.

The levels of EOX and EPOX in yogurt were in the order of $\text{EOCl} \gg \text{EOI} > \text{EOBr}$ and $\text{EPOCl} \gg \text{extractable persistent organoiodines (EPOI)} > \text{extractable persistent organobromines (EPOBr)}$ (see Table 1), respectively, which agreed well with the results obtained for Chinese milk reported earlier [2]. But they were different from the distributions of $\text{EOCl} \gg \text{EOBr} > \text{EOI}$ and $\text{EPOCl} \gg \text{EPOBr} > \text{EPOI}$ in apple (see Table 1) and the results reported by Xu et al. [14] for terrestrial vegetation, by Kannan et al. [17] for aqueous biota and by Laniewski et al. [18] for rain and snow. The reasons for this difference may be partly attributed to the different iodine metabolism route among mammal and vegetation. Pavelka et al. [19] demonstrated that the two main routes of iodine excretion from body in lactating females were through the mammary glands into milk and through the kidneys into urine. In this case, theoretically, the content of organic iodinated compounds in milk is likely higher than in vegetation. Further, the results also indicated that organochlorines were the main residue species of organohalogens.

Table 1. The average concentrations and range of total halogens, EOX and EPOX in yogurt and apple samples (mg/kg, fresh weight).

	Yogurt (n=20)	Apple (n=9)
Lipid (%)	2.6	0.59
	1.2-6.3	0.35-0.95
EOCl	0.15	0.22
	0.048-0.47	0.17-0.28
EOBr	0.0013	0.0060
	ND-0.0033	0.0029-0.017
EOI	0.0046	0.0020
	0.0014-0.013	0.0013-0.0034
EPOCl	0.03	0.072
	0.0074-0.051	0.042-0.15
EPOBr	0.00048	0.0019
	ND-0.00054	0.00068-0.0037
EPOI	0.0015	0.00093
	0.00046-0.0038	0.00018-0.0018
Total Cl	940	7.4
	630-1500	5.0-14
Total Br	2.2	0.015
	0.63-5.5	0.0095-0.033
Total I	0.11	0.0060
	0.035-0.27	0.0031-0.011

Since no data on the concentration of organic chlorinated compounds in yogurt and apple are available, other biological samples are used for comparison. On the lipid weight basis, the concentrations of EOCl in yogurt (6.3 $\mu\text{g/g}$) and apple (42 $\mu\text{g/g}$) were much lower than those of fish (595 to 2170 $\mu\text{g/g}$, lipid weight), bird (560 to 3080 $\mu\text{g/g}$, lipid weight) at estuarine marsh near a former chloralkali plant [17]. The high concentration of EOX in latter matrix is likely attributed to the disposal of wastes from the chloralkali process and the bioaccumulation through the food chains. On the other hand, the direct use of OCP and low

lipid content were probably the main reasons of 6 to 7-fold higher concentration of EOCl in apple samples.

Although natural EPOCl could not be neglected, its contribution to sample is probably limited in comparison with anthropogenic EPOCl, because the most natural organochlorines with heteroatoms (oxygen or nitrogen atom) or an unsaturated bond could be protonated or decomposed and removed from the extracts after treatment with concentrated sulfuric acid [12,20]. Thus, a correlation ($r = 0.50, P < 0.05$) between the concentrations of EOCl and EPOCl in yogurt suggested that major fractions of EOCl and EPOCl in yogurt samples came from anthropogenic organochlorine sources. For apple, there was a correlation between the concentrations of EOBr and EOI ($r = 0.79, P < 0.05$), but no correlations between the concentrations of EOCl and EOBr or EOI, which implied that EOBr and EOI in apple mainly came from natural source, whereas EOCl mainly came from anthropogenic organochlorine sources.

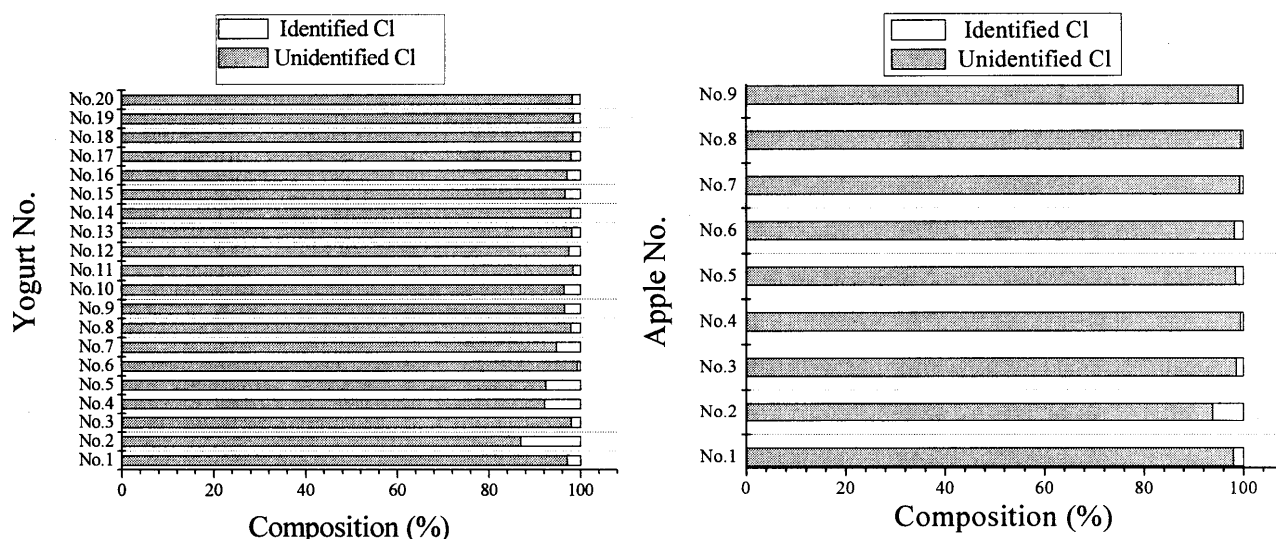


Figure 2 Distributions of identified Cl and unidentified Cl in EPOCl of yogurt and apple samples.

The distributions of identified chlorine, that is, the sum of OCP and PCB determined by GC expressed as chlorine, and unidentified chlorine in EPOCl of twenty brands of Chinese commercial yogurt specimens and nine different kinds of apple samples are shown in Figure 2. The results indicated that 0.7 to 13.1 % of total EPOCl in yogurt, and 0.5 to 6.2 % in apple, were accounted for, which indicated that a major portion of EPOCl measured in yogurt and apple samples remained uncharacterized. The identified organochlorines were reported to account for 5 to 25 % of EOCl in fish and 1 to 14 % in birds from Georgia, United States [17], 2 to 18 % in marine organisms from the Osaka Bay and about 59 % in Japanese human adipose [11], 25 to 50 % in herring gull eggs from the Lake Ontario [21] and about 45 % in blubber lipid of beluga whales [10]. In contrast with the above results, a conclusion could be drawn that relative proportions of the unidentified EOCl in yogurt and apple samples are higher than those found in aqueous and terrestrial biota.

Thus, much work on identification of organohalogens in foodstuffs is highly needed.

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研究会報告

Methods and Applications of Radioanalytical Chemistry VII

[2006年4月3日~7日]

石巻専修大学理工学部 福島美智子

MARC VIIが2006年4月3日から7日の期間に開催された。MARC (Methods and Applications of Radioanalytical Chemistry)は3年に一度、ハワイ島コナの海岸に面した King Kamehameha's Kona Beach Hotel を会場に行われ、今回7回目であった。MARC VIIのホームページ(まだ開いている。http://altmine.mie.uc.edu/nuclear/marc/index.shtml)によると、初回は1987年に開かれ、そのあとは1991, 1994, 1997, 2000, 2003そして2006の今回ということになる。わたしはMARC IIIに初めて参加し、以後V, VIIと奇数回のみ参加している。これは特別意図したわけではない。いまこの原稿を書いているのが12月なので、学会に参加してから8ヶ月が過ぎたため、詳細は記憶に残っていない。来年に日本で開催する予定のMTAA12の事が気になっているためか、学会の運営に関することばかりが記憶に残っている。

会場で配布された参加者リストをもとに数えてみると、参加者234名で、そのうち11名が日本人であった。学会の初日には、International Committee on Activation Analysis (ICAA)とJournal of Radioanalytical and Nuclear ChemistryとMARC VIIの組織委員会により、Hevesy AwardがチェコのDr. Jan Kuceraに授与された。わたしは初日の10時頃に会場に到着したので、残念ながらJanの授賞式と講演の場にいることはできなかった。しかし、ホテルの庭で行われたFarewell Receptionの折、Jan Kuceraがかつてディスコでとても目立つ存在だったことを知った。本物を見ないと彼のダンスの腕(?)前のすごさは伝わらないと思うが、Hevesy Medal受賞者のダンスを図1に紹介する。

学会は毎日朝8時にスタートし、あまり重なりなさそうなふたつの分野について口頭発表が平行に行われた。各会場の機材係は、学生がアルバイトとして毎日行っていた。わたしは時々会場に不在だったので、自信はないが、同じ学生がひとつの会場を毎日担当していたと思う。二人のうちの一は、わたしが時々実験にでかけているカナダのダルハウジー大の学生だったこともあり、学会中に聞いてみたところ、アルバイト料として300\$くらい支払われたとのことであった。このMARCの会議では、いつも組織委員会のメンバーだけで学会中も会の運営をしていて、機材係以外のアルバイトの学生を見た記憶がない。

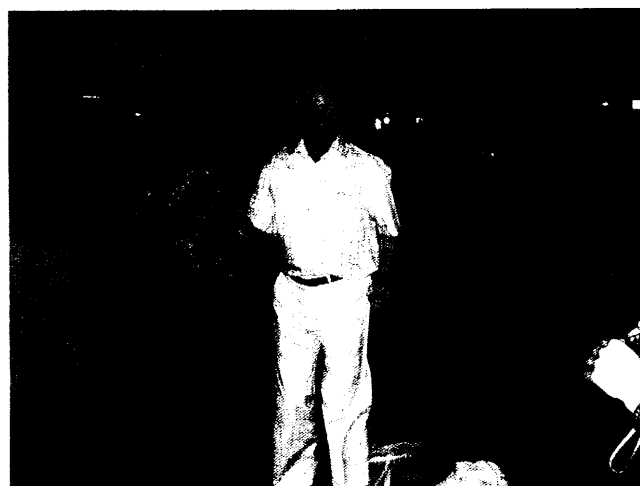


図1. ダンスする Hevesy Medal 受賞者 Dr. Jan Kucera.

日本国内でわたしが参加する学会は、ひとつの会場に4人くらいのアルバイト学生がいて、運営委員の仕事はアルバイト学生のお世話が主になることもある。どうせ同じ時間仕事をすることに

なるのだから、アルバイトの数を減らして運営費の支出を抑える、という考え方もあるだろう。

ポスターセッションは2グループに分けて、3:20 p.m.から5:00 p.m.まで、2日間行われた。ひとつのポスター会場は狭さを解消するためか、パネルを屏風状に配置していたが、ますます会場が狭くなり、あまりよいアイデアとは思えなかった。

ポスターもオーラルもともに会場にはあまり人が入っていなかった。オーラル発表の会場もあまり大きくなかったが、用意された席の4-6割くらいが埋まっているくらいだった。最終日のクロージングセッションの少し前のセッションの様子を図2に示す。



図2. 最終日、Closing session 前の会場。
がらあき.....

学会でアブストラクト集を受け取ったかどうか、記憶にない。現在手元にはないのは、帰国してから処分したのかもしれないし、はじめからなかったのかもしてない。記憶が不鮮明で申し訳ないが、手元にある薄いプログラムには Final Program and Abstracts というタイトルになっている。ということは、やはり要旨集はなかったように思える。プログラムに改めて目を通すと、3回行われた夕方の social program はすべて開始時間が入っていない。時間はお楽しみ、という配慮なのか、それとも、プログラム作成時にまだ決定していなかった

のか。開始時間がわからないと不便なこともあると思う。

不満な点は登録費用である。Pre-Resistration で会員は\$450、非会員\$600、学生\$350であるが、当日受付で+\$100となる。ただし学生の登録費は同じ\$350である。ここでの会員は American Nuclear Society, Canadian Nuclear Society, American Chemical Society の3学会の所属会員を意味する。手元に残っていた MARC III のプログラムを見ると、当時は American Nuclear Society の3つの division が主催していて、Chemical Society of Japan Atomic Energy と Society of Japan for Analytical Chemistry を含む11団体が共催になっている。私は日本分析化学会会員であるため、当時の登録費用は当日払いでも安い、と感じたが、今回の MARC VII で当日の登録費が\$700というのは、高いと感じる。これまでに参加した2回の学会と同じ Luau(ハワイ島の伝統的な踊りや歌を楽しみながらの dinner)を、カナダの Dr. A. Chatt が“これまで6回撮影したのとまさに同じ映像。違う点は、以前はビデオカメラ、今はDVDカメラ。”、と言いながら撮影しているのがおかしかった。

パーティの食事はおいしい、海風に吹かれてリラックスできる、思い立ったときにホテルの前の海でゆらゆらと海水浴を楽しむ事ができる、その気になれば海でのフィッシングや火山へのドライブ、天文台見学などもできる。日本からは比較的短時間で行ける。しかし、日本にはイースター休暇がないので、4月の最初に職場を離れるのはとても難しい。同じ場所、同じ大会運営というのも、様子がわかっているからよい、とも言えるが、正直なところ少々飽きて来た。この学会の運営が若い世代にバトンタッチされるようであるが、何か変化があることを期待したい。

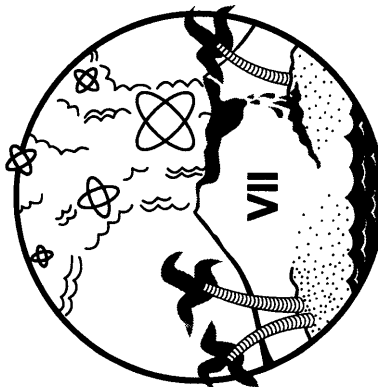
次ページに MARC VII のプログラム(抜粋)を掲載する[編集委員会]

American Nuclear Society
International Topical Conference

Final Program and Abstracts

Seventh International Conference on
Methods and Applications of
Radioanalytical Chemistry

MARC VII



KAILUA-KONA, HAWAII, USA
APRIL 3 – 7, 2006

Program

The MARC VII Conference is dedicated to Prof. Dr. Jeroen J.M. de Goeij,
Delft University of Technology, The Netherlands.

Sunday, April 2

3:00-5:00 p.m. Conference Registration and Informal Reception (Registration available throughout conference) at the King Kamehameha's Kona Beach Hotel.

Monday, April 3

7:30 a.m. – 5:00 p.m. Registration

7:50 a.m. Conference Opening Remarks. Dr. Steve Carpenter, General Chairman and Dr. Sam Glover, Technical Program Chair

8:00-8:15 a.m. Memorial to Prof. Jeroen de Goeij. Dr. Peter Bode, Delft University of Technology

8:15-9:15 a.m. 2006 HEVESY MEDAL AWARD CEREMONY AND LECTURE. Introduction and presentation: Prof. A. Chait, Dalhousie University, Chair of Hevesy Medal Selection Panel and President of International Committee on Activation Analysis. Hevesy Medal Award Lecture: Dr. Jan Kucera: "Methodological developments and applications of neutron activation analysis".

9:15-9:30 Coffee Break

TUESDAY, APRIL 4

Session 3

Tuesday, 8:00 a.m. to 12:00 p.m.

Oral Section 1

Instrumentation and Software for Nuclear Spectrometry.
Organized and chaired by A. Berlizov, National Academy of Sciences of Ukraine, UKRAINE; and R. Lindstrom, NIST, USA.

Time	LOG	Title	Authors
8:00	197	THE PERFECTION OF LOSS-FREE COUNTING	G. P. Westphal and H. Lemmel. Atominstiut der Oesterreichischen Universitaeten, Stadionallee 2, A-1020 Vienna, Austria
8:20	151	IMPROVED PERFORMANCE IN GERMANIUM DETECTOR GAMMA SPECTROMETERS BASED ON DIGITAL SIGNAL PROCESSING	R.M. Keyser, R.D. Bingham, and T.R. Twomey; ORTEC, 801 South Illinois Avenue; Oak Ridge, TN 37831
8:40	346	A COMPARISON OF PULSER-STABILISED ANALOG SPECTROMETERS AND DIGITAL SPECTROMETERS	C.A. McGrath, R. J. Gehrke, J. K. Hartewell, Idaho National Laboratory
9:00	300	A MULTIPLE TIME-GATED SYSTEM FOR PULSED DIGITAL GAMMA-RAY SPECTROSCOPY	H. Tan, S. Mitra, L. Wielopolski, A. Fallu-Labruyere, W. Hennig, Y. X. Chu, W. K. Warburton. XIA LLC, 8450 Central Ave, Newark, CA 94560 USA, Department of Environmental Sciences, Earth Systems Science Division, Brookhaven National Laboratory, Upton, NY 11973 USA.
9:20	349	A SIMPLE DUAL ENERGY LUMP CORRECTION MODEL FOR USE IN THE QUANTITATIVE GAMMA ASSAY OF PLUTONIUM	Stephen Croft, Robert D McElroy, Jr and Ram Venkataramen Canberra Industries Inc. and Debbie Curtis Canberra Harwell Ltd.
9:40			Coffee and Juice Break
10:00	158	USING ADVANCED ALGORITHMS AND FASTER PROCESSING TO OBTAIN BETTER AUTOMATIC ISOTOPE IDENTIFICATION RESULTS	Benjamin Sapp, Robert Estep, Mohini Rawool-Sullivan, Clair Sullivan, Los Alamos National Laboratory;
10:20	267	DEVELOPMENT AND APPLICATIONS OF TIME-OF-FLIGHT NEUTRON DEPTH PROFILING	Sacit M. Çetiner, Kenan Ümiti (Penn State University, Department of Mechanical and Nuclear Engineering), R. Gregory Downing (NIST)

10:40	190	THE USE OF COLLOIDION FILMS TO PROTECT SOLID STATE ALPHA DETECTORS FROM HEAVY ION RECOILS	Barry D. Stewart, CEMRC/NMSU; Edward Hall, University of Rochester; Kenneth G. W. Inn, NIST
11:00	291	LINSS - DATABASE FOR GAMMA-RAY SPECTROMETRY	ertti Aarnio ¹ , Jarmo Ala-Heikkilä ¹ , Anto Isolanikla ² , Antero Kuusi ² , Mikael Moring ² , Mika Nikkinen ² , Teemu Siiskonen ² , Harri Toivonen ² , Kurt Ungar ³ , Weihua Zhang ³ ; ¹ -Helsinki University of Technology, Laboratory of Advanced Energy Systems; ² -Radiation and Nuclear Safety Authority, STUK; ³ -Health Canada, Radiation Protection Bureau
11:20	162	PROBABILISTIC UNCERTAINTY ESTIMATOR FOR GAMMA SPECTROSCOPY MEASUREMENTS	Frazier Bronson, Canberra
11:40	157	MODELING OF GAMMA-RAY SPECTRA TO DIRECT EFFICIENT CHEMICAL SEPARATIONS	Matthew Douglas, Judah I. Friese, Glen A. Warren, Paula P. Bachelor, O. Tom Farmer III, Andrea D. Choiniere, Shannon M. Schulte, Craig E. Aalseth

Lunch 12 p.m. - 2:00 p.m.

Session 5

Tuesday, 8:00 a.m. to 12:00 p.m.
Oral Section 2

Activation Analysis: Environmental Applications and Instrumentation.
Organized and chaired by S. Landsberger, University of Texas, USA.

Time	LOG	Title	Authors
8:00	219	TAKING A SIP FROM A VOLCANIC COCKTAIL	Johannes H. Sierba, Georg Steinhäuser, Max Bichler, Atominsstitut of the Austrian Universities, Vienna University of Technology
8:20	218	ON BARIUM ANOMALIES IN CONTEXT WITH VOLCANIC ACTIVITIES IN THE AEGEAN	Georg Steinhäuser, Johannes H. Sierba, Max Bichler (Atominsstitut of the Austrian Universities), Robert Seemann (Museum of Natural History Vienna)
8:40	105	JOINT ASSESSMENT OF RESPONSES OF BIOMONITORS TO AIRBORNE NICKEL AND VANADIUM THROUGH NUCLEAR AND NON-NUCLEAR TECHNIQUES	A.M.G. Pacheco ¹ , M.C. Freitas ² , S. Sarmento ³ , M.S. Baptista ⁴ , M.T. Vasconcelos ^{3,4} , J.P. Cabral ^{3,5} – 1CVRM-IST (Technical University of Lisbon), Av. Rovisco Pais, 1049-001 Lisboa, Portugal; ² Reactor-ITN (Technological and Nuclear Institute), E.N. 10, 2686-953 Sacavém, Portugal; ³ CiMAR (University of Porto), Rua dos Bragas 289, 4050-123 Porto, Portugal; ⁴ Chemistry Department – Faculty of Sciences (University of Porto), Rua do Campo Alegre 687, 4169-071 Porto, Portugal; ⁵ Botany Department – Faculty of Sciences (University of Porto), Rua do Campo Alegre 1191, 4150-181 Porto, Portugal
9:00	251	DETERMINATION OF CADMIUM HIGH-ARCTIC AIR FILTERS BY EPITHERMAL NEUTRON ACTIVATION ANALYSIS AND COMPTON SUPPRESSION	S. Landsberger, A. Massicotte, J. Braisted, University of Texas, Nuclear Engineering Teaching Lab, PRC, R-9000, Austin, Texas, USA 78712

9:20	385	ATLANTIC FOREST: A NATURAL RESERVOIR OF CHEMICAL ELEMENTS	Elvis Joacir De França, Elisabete A. De Nadai Fernandes, Márcio Arruda Bacchi, Camilla Elias
9:40		Coffee and Juice Break	
10:00	212	NEUTRON ACTIVATION ANALYSIS FOR IDENTIFICATION OF AFRICA MINERAL DUST TRANSPORT	S.M. Almeida ¹ , M.C. Freitas ¹ , C.A. Pico ² , Instituto Tecnológico e Nuclear, Apartado 21, E.N.10, 2686-953 Sacavém, Portugal, ² Departamento de Ambiente e Ordenamento, Universidade de Aveiro, ³ Laboratório de Análises Ambientais e Controlo de Qualidade, INETI, Portugal
10:20	232	NON-CARBON BASED COMPACT SHADOW SHIELDING OF 14 MEV NEUTRONS	Lucjan Wielopolski, Sudeep Mitra with Brookhaven National Laboratory, Oted Doroni, University of Texas at Austin
10:40	126	INVESTIGATION OF THE DESTRUCTION OF CHEMICAL WARFARE AGENTS USING IONIZING RADIATION	William S. Andrews, Edward A. Ough, Dragic Vukomanovic and Katherine A.M. Creber, Chemistry and Chemical Engineering, Royal Military College of Canada, Kingston ON CANADA K7K 7B4
11:00	310	MEASUREMENTS OF PRESOLAR GRAIN IN METEORITE USING NEUTRON ACTIVATION ANALYSIS WITH MULTIPARAMETER COINCIDENCE METHOD	Y. Hatsukawa, Y. Miyamoto, T. Hayakawa, Y. Toh, A. Kimura, M. Oshima, Japan Atomic Energy Agency
11:20	268	DELAYED NEUTRON ACTIVATION ANALYSIS FOR SAFEGUARDS	David Glasgow, Oak Ridge National Laboratory
11:40	147	NEUTRON FLUX VARIATION IN K0-INAA, EXPERIENCES AND SOLUTION IN KAYZERO FOR WINDOWS	R. van Sluijs, K0-ware, Heerlen, The Netherlands; D. Bossus, J. Swagten, DSM, Geleen, The Netherlands; A. De Wispelaere and F. De Corte, RUG, Gent, Belgium

Lunch 12:00 p.m. – 2:00 p.m

WEDNESDAY, APRIL 5**Session 7**

Wednesday, 8:00 a.m. to 9:45 a.m.
Oral Section 1

Activation Analysis: Speciation, Pre-concentration and Other Applications. Organized and chaired by A. Chatt, Dalhousie University CANADA

Time	LOG	Title	Authors
8:00	400	TOP-DOWN VERSUS BOTTOM-UP ESTIMATES OF UNCERTAINTY IN INAA RESULTS.	Peter Bode (a), Elisabete A.De Nadal Fernandes(b), Marco A.Bacchi(b), (a) Delft University of Technology, Reactor Institute Delft, Delft, The Netherlands; (b) Centro de Energia Nuclear na Agricultura, Universidade de São Paulo, Piracicaba, Brazil
8:15	121	AUTOMATIC NAA - SATURATION ACTIVITIES	G. P. Westphal and F. Grass Atominsstitut der Oesterreichischen Universitaeten, Stadionallee 2, A-1020 Vienna, Austria
8:30	124	DETERMINATION OF LOW LEVEL SULFUR IN STEELS BY RADIOCHEMICAL NEUTRON ACTIVATION ANALYSIS WITH LIQUID SCINTILLATION COUNTING	Rick L. Paul, National Institute of Standards and Technology, Gaithersburg, MD 20899
8:45	196	DETERMINATION OF PHOSPHOROUS IN ORGANIC MATERIALS BY INSTRUMENTAL PHOTON ACTIVATION ANALYSIS (INAA)	W.Goerner, Chr. Segebade, M. Ostermann, O.Haase Federal Institute for Materials Research and Testing, Berlin, Germany
9:00	123	OXYANION MATERIALS ANALYSES BY PROMPT GAMMA ACTIVATION ANALYSIS (PGAA)	D.L. Perry, G. A. English, R. B. Firestone, K.-N. Leung
9:15	369	SPECIATION ANALYSIS OF IODINE IN BOVINE MILK BY CHEMICAL SEPARATION AND NEUTRON ACTIVATION	Keila Isaac-Olive, A. Chatt, SLOWPOKE-2 Facility, Trace Analysis Research Centre, Department of Chemistry, Dalhousie University, Halifax, Nova Scotia, B3H 4J3, Canada

9:30 376 PROTEIN- AND POLYSACCHARIDE-BOUND TRACE ELEMENTS IN EDIBLE JAPANESE SEAWEEDS BY NEUTRON ACTIVATION

M. Fukushima¹, K. Isaac-Olive², Y. Nakano³, A. Chatt⁴,
¹Ishinomaki Senshu University, Ishinomaki, Miyagi, 986-8580, Japan; ²SLOWPOKE-2 Facility, Dalhousie University, Halifax, Nova Scotia, B3H 4J3, Canada; ³Research Reactor Institute, Kyoto University, Semmann, Osaka, 590-0494, Japan

9:45 Coffee and Juice Break

Session 8

Wednesday 10:00 a.m. to 3:20 p.m.
Oral Section 1

Gamma Spectrometry and Neutron Measurements for Safeguards. Organized and chaired by R. Brodzinski and R. Runkle, PNNL, USA.

Time	LOG	Title	Authors
10:00	339	QUANTITATIVE GAMMA-RAY SPECTROSCOPY	Henry C. Griffin, Dept. of Chemistry, Univ. of Michigan, Ann Arbor
10:30	406	SUPERCONDUCTING ULTRA-HIGH ENERGY RESOLUTION GAMMA AND FAST-NEUTRON SPECTROMETERS	S. Friedrich, S. Ali, S. F. Terracol, O. B. Drury, I. D. Hau, T. R. Niedermayr, Lawrence Livermore National Laboratory, U. Roy, A. Burger, Fisk University
11:00	351	THE MULTIPLE ISOTOPE MATERIAL BASIS SET (MIMBS) METHOD FOR ISOTOPE IDENTIFICATION WITH LOW- AND MEDIUM-RESOLUTION GAMMA RAY DETECTORS	Robert Estep, Los Alamos National Laboratory, Benjamin Sapp, Los Alamos National Laboratory
11:20	129	COMPARISON OF PORTABLE DETECTORS FOR URANIUM ENRICHMENT AND HOLDUP MEASUREMENTS	Duc T. Vo, Los Alamos National Laboratory, Group N-1, MS E-540, Los Alamos, NM 87545, USA
11:40	248	ANALYSIS OF LOW-COUNT GAMMA-RAY SPECTRA USING SPECTRAL COMPARISON RATIOS	Robert Runkle, PNNL

Lunch 12:00 p.m. – 2:00 p.m.

Session 16

Friday, 8:00 a.m. to 12:20 p.m.

Oral Section 1

Activation Analysis: Radioanalytical Methods and Applications to the Life Sciences. Organized and chaired by S. Morris, University of Missouri, USA.

Time	LOG	Title	Authors
8:00	111	COHN ANALYSIS: BODY COMPOSITION MEASUREMENTS BASED ON THE ASSOCIATED PARTICLE IMAGING AND PROMPT-GAMMA NEUTRON ACTIVATION ANALYSIS TECHNIQUES	Kenneth J. Ellis, Roman J. Shypalo, USDA/ARS Children's Nutrition Research Center, Dept. Pediatrics, Baylor College of Medicine, 1100 Bates St., Houston, TX 77030
8:20	193	MULTIELEMENT ANALYSIS OF BONE FROM THE OSTEOGENESIS IMPERFECTA MODEL (OIM) MOUSE USING THERMAL AND FAST NEUTRON ACTIVATION ANALYSIS.	C. E. Buff ¹ , S. M. Cartleton ² , D. J. McBride ⁵ , C. T. Winkelman ³ , C. L. Phillips ⁴ , and J. S. Morris ¹ . 1- University of Missouri Research Reactor Center, Columbia, MO 65211, USA; 2-Genetics Area Program, Departments of 3- Veterinary Pathobiology, and 4- Biochemistry, University of Missouri-Columbia, Columbia, MO; 5-Division of Endocrinology, Diabetes and Nutrition, University of Maryland, Baltimore, MD.
8:40	247	LIMITS AND OPPORTUNITIES OF INAA DETERMINATIONS IN SERUM AND BRAIN TISSUE SAMPLES	Rolf Zeisler, Elizabeth A. Mackey, Analytical Chemistry Division, NIST, and Lin-wen Hu, Nuclear Reactor Laboratory, MIT
9:00	181	DYNAMICS OF ELEMENTAL COMPOSITION DURING NEURONAL DEATH IN MUTANT-MICE BRAINS MONITORED WITH NEUTRON ACTIVATION ANALYSIS	K. KRANDA, J. KUCERA (Nuclear Physics Institute and Research Centre, Ltd., Rez, Czech Republic), J. Baeurle (Charite - Universitaetsmedizin, Berlin, Germany)
9:20	283	MEAN RESIDENCE TIMES IN GASTROINTESTINAL TRACTS OF CHICKENS USING STABLE RARE EARTH MARKERS AND NEUTRON ACTIVATION ANALYSIS	W. D. James, Center for Chemical Characterization and Analysis, Texas A&M University, College Station, TX 77843, C.S. Dunkley, W-K Kim and S.C. Ricke, Poultry Science Department, Texas A&M University, College Station, TX 77843
9:40		Coffee and Juice Break	

10:00	112	COMPTON SUPPRESSION SPECTROMETRY FOR ANALYSIS OF SHORT-LIVED NEUTRON ACTIVATION PRODUCTS IN FOODS	David L. Anderson and William C. Cunningham, Elemental Research Branch (HFS-338), U. S. Food and Drug Administration, 5100 Paint Branch Parkway, College Park, MD (USA) 20740-3835
10:20	364	RADIOANALYTICAL TECHNIQUES APPLIED TO FOOD SAMPLES TO MONITOR THE NUTRITIONAL STATUS OF CHILDREN FROM TANZANIA	Mohammed, N.K., Spyrout, N.M. Department of Physics, University of Surrey, Guildford, Surrey, GU2 7XH, UK.
10:40	360	CHEMICAL ANALYSIS OF BRAZILIAN COMMERCIAL MILKS BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS	Luís Gustavo Colani dos Santos, Elisabete A. De Nadai Fernandes, Fábio Sileo Tagliaterra and Márcio Arruda Bacchi - Laboratório de Radioisótopos - Centro de Energia Nuclear na Agricultura - Universidade de São Paulo
11:00	144	AVAILABILITY OF ESSENTIAL TRACE ELEMENTS IN MEDICINAL HERBS USED FOR DIABETES MELLITUS AND THEIR POSSIBLE CORRELATIONS.	R. Paul Choudhury ¹ , R. Acharya ² , A.G.C. Nair ² , A.V. R. Reddy ² and A.N. Garg ^{1*} . 1-Department of Chemistry, Indian Institute of Technology Roorkee, Roorkee-247667, Uttaranchal, INDIA. 2- Radiochemistry Division, Bhabha Atomic Research Centre, Trombay, Mumbai-400085, INDIA
11:20	164	TRACE ELEMENTS DISTRIBUTION IN BENIGN BREAST DISEASES FIBROADENOMA MEASURED BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS	ABUGASSA, I. O., ABUGASSA, S. O., DOUBALY, K., BASHIT, T.A. (RENEWABLE ENERGY AND WATER DESALINATION CENTER)
11:40	171	LARGE-SAMPLE ACTIVATION ANALYSIS -PROCESS MONITORING USING RADIOANALYTICAL METHODS	C. Segebeade, M. Hedrich, L. Giese, W. Goerner and C. Adam, Federal Institute for Materials Research and Testing, Berlin, Germany
12:00	399	NEUTRON ACTIVATION ANALYSIS AND X-RAY RAYLEIGH SCATTERING OF HAIR AND NAIL CLIPPINGS AS NON-INVASIVE MONITORING TECHNIQUES REDUCING THE BURDEN OF ANIMAL TESTS	Peter Bode ^(a) , Maria Izabel Maretti Silveira Bueno ^(b) , Gisele G. Bortoloto ^(b) , Gaby Hoffmann ^(c) , Jan Rothuizen ^(c) . (a) Delft University of Technology, Reactor Institute Delft, Delft, The Netherlands; (b) Instituto de Química, Universidade Estadual de Campinas, Campinas, SP, Brazil; (c) Department of Clinical Sciences of Companion Animals, Faculty of Veterinary Medicine, Utrecht University, The Netherlands.

- 383** EVALUATION OF SEMICONDUCTOR DETECTORS TO IMAGE THREE PHOTON ANNIHILATION FOR POSITRON EMISSION TOMOGRAPHY. Eifatih Abuelhia (Department of Physics, University of Surrey, Guildford, Surrey, GU2 7XH, UK), K. Kacperski (Institute of Nuclear Medicine, University College London, Middlesex Hospital, London W1T 3AA, UK), S. Kafala (Department of Physics, Universit
- 413** USING THE RESULTS OF GAMMA-SPECTROMETRY MEASUREMENTS IN BOREHOLES TO DETERMINE THE MECHANISM OF RADIOACTIVE CONTAMINATION OF GROUNDWATER. A.K. Kalyonovskiy, O.O. Odintsov, V.A. Krasnov. Institute for Safety Problems of NPP, National Academy of Sciences of Ukraine, Chernobyl, 07270, Ukraine

5-Activation Analysis: Environmental applications and instrumentation

- 109** BULK AND TRACE ELEMENT CONTENTS IN SPICES FROM SRI LANKA DETERMINED BY ICP-MS, NUCLEAR AND NUCLEAR-RELATED TECHNIQUES. ¹Chery, ¹Van Lierde, ¹Vanhaecke, ²Jayasekera, ³Freitas ¹Laboratory of Analytical Chemistry, Ghent University, Institute for Nuclear Sciences, Proefuinstaat 86, B-9000 Ghent, Belgium, Frank.Vanhaecke@UGent.be, ²Department of Botany, University of Kela
- 110** TRACE-ELEMENT CONTENTS IN RAW FOOD ITEMS CONSUMED IN MAIN AND PORTUGAL, DETERMINED BY K0-INAA. Freitas ¹, Ventura ¹, Bacchi ², Dionisio ¹, Pacheco ³, 1- ITN (Technological and Nuclear Institute), Reactor, E.N. 10, 2686-953 Sacavém, Portugal, cfreitas@itn.pt, 2-S. Paulo University, Nuclear Energy Center for Agriculture, University of São Paulo, CENA
- 131** AEROSOL MEASUREMENT USING NEUTRON ACTIVATION ANALYSIS (NAA). Cheryl Olson, Los Alamos National Lab/University of Texas Jon Braisted, University of Texas, Sheldon Landsberger, University of Texas
- 132** NUCLEAR DATA AND THE EFFECTS OF ITS INCONSISTENCY ON INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Y.A. Ahmed; I.O.B. Ewa; I.M. Umar Centre for Energy Research and Training, Ahmadu Bello University, Zaria, Nigeria.

- 233** ADVANTAGES OF MESH TALLYING IN MCNP5 FOR SOIL ANALYSIS CALCULATIONS. Oded Doron, University of Texas at Austin; and Lucian Wloppolski, Brookhaven National Laboratory
- 249** DISTRIBUTION OF ENVIRONMENTAL RADIONUCLIDES IN SEDIMENT CORE OF THE JINHEUNG CATCHMENT. Yoon Yeol Yoon¹, Chul Soo Kim², Dong Yoon Yang¹, Kil yong Lee¹, Soo Young Cho¹. ¹-Korea Institute of Geoscience and Mineral Resources, 2-Korea Institute of Nuclear Safety
- 261** A PCNAA METHOD FOR THE DETERMINATION OF ²³²TH IN A DRY-TUBE IRRADIATION ENVIRONMENT. Gels, J.L.; Spitz, H.B.; Glover, S.E. Department of Mechanical, Industrial and Nuclear Engineering, University of Cincinnati
- 263** NEUTRON ACTIVATION ANALYSIS DATA OF AIR-FILTERS COLLECTED IN SPOKANE WA.. Daniel Dugan, WSU-NRC; Dr. Roy Filby, WSU Chemistry; Dr. James T. Elliston, WSU-NRC; Dr. Paul Buckley, Lewis and State College; Dr. Candis Claiborn, WSU Environmental Engineering
- 315** DEVELOPMENT OF MULTIPLE PROMPT GAMMA RAY ANALYSIS. Yosuke Toh, Masumi Oshima, Mitsuo Koizumi, Aisushi Kimura, Yuichi Hatsukawa
- 353** PM 2.5 EXPOSURE FROM VEHICULAR EMISSIONS. C. M. Butler*, N.M. Spyrou*, I. Matthews**, C. Au-Yeung***

8-Gamma Spectrometry and Neutron Measurements for Safeguards

- 170** PLUTONIUM ISOTOPIC MEASUREMENTS AND URANIUM ENRICHMENT MEASUREMENTS USING LACL₃(CE) AND LABR₃(CE) GAMMA-RAY DETECTORS. Mohini W. Rawool-Sullivan (N-2), John P. Sullivan (ISR-1) and Tracy R. Wenz (N-1), Los Alamos National Laboratory, Los Alamos, NM 87545, USA
- 199** FAST NEUTRON INDUCED FISSION NEUTRON SPECTRA BELOW THE INCIDENT ENERGY. Mitchell Woodring, James Egan, Gunter Kegel, Parrish Staples, David DeSimone

- 320** AGE DETERMINATION OF PLUTONIUM USING ICP-SFMS. Ulrika Nygren^{1,2}, Henrik Ramebäck¹ and Calle Nilsson¹, Swedish Defence Research Agency (FOI), Division of NBC Analysis, SE-901 82 Umeå, Sweden, ²Division of Chemistry, Luleå University of Technology, SE-971 87 Luleå, Sweden
- 354** ULTRA LOW LEVEL MEASUREMENTS OF ACTINIDES BY QUADRUPOLE-BASED ICP-MS. F. Pointhier, A. Hubert, Ph. Hemet, Commissariat à l'Energie Atomique, DAM/DIF/DASE/SRCE
- 7-Activation Analysis: Speciation and preconcentration**
- 104** MEASUREMENT OF ULTRA-TRACE LEVEL MOLYBDENUM IN SILICON WAFERS UTILIZING NEUTRON ACTIVATION ANALYSIS. Craig Swanson and Albert Filo, Eastman Kodak Co, 1999 Lake Ave, Rochester, NY 14420, USA
- 122** WASHINGTON STATE UNIVERSITY NUCLEAR RADIATION CENTER. E. Corwin, K. Fox. Nuclear Radiation Center, Washington State University
- 229** NEUTRON DEPTH PROFILING COLLABORATION BETWEEN THE UNIVERSITY OF TEXAS AT AUSTIN AND NIST. S. M. Whitney (The University of Texas at Austin), S. R. Biegalski (The University of Texas at Austin), R. G. Downing (NIST)
- 243** NEUTRON ACTIVATION EXPERIMENTS FOR BREMSSTRAHLUNG CHARACTERIZATION STUDIES. D.R. Reinert and S.R. Biegalski, The University of Texas at Austin
- 250** CLASSIFICATION AND PROVENANCE DETERMINATION OF ARCHAEOLOGICAL POTTERY FROM THE EAST AEGEAN BY NEUTRON ACTIVATION ANALYSIS (NAA). H. Mommsen and M. Kerschner¹ Helmholtz-Institut für Strahlen- und Kernphysik, University Bonn, Nussallee 14-16, 53115 Bonn, Germany, mommsen@hiskp.uni-bonn.de ¹Österreichisches Archäologisches Institut, Franz Klein-Gasse 1, 1190 Vienna, Austria
- 259** FIRST EXPERIMENTS ON A NEW IN-BEAM MÖSSBAUER SPECTROSCOPY STATION AT THE BUDAPEST RESEARCH REACTOR. T. Belgya and K. Lázár, Institute of Isotopes of the Hungarian Academy of Sciences H-1525, Budapest, POB 77

- 290** MEASUREMENT OF ERBIUM ISOTOPES IN IRRADIATED TRIGA FUEL: A PROPOSED INTERNAL STANDARD FOR DETERMINING THE "DEGREE OF THERMALIZATION" OF TRIGA REACTORS.. Michael Michlik, James Sommers, Mary Adamic, Kevin Carney and Jeffrey Giglio
- 302** OXYANION MATERIALS ANALYSES BY PROMPT GAMMA ACTIVATION ANALYSIS (PGAA). D.L. Perry, G. A. English, R. B. Firestone, K.-N. Leung
- 337** DETERMINATION OF AS(III) AND AS(V) IN DRINKING WATER BY SOLID PHASE EXTRACTION AND NEUTRON ACTIVATION. Wilber Menendez Sanchez, Blaine Zwicker, A. Chatt, SLOWPOKE-2 Facility, Trace Analysis Research Centre, Department of Chemistry, Dalhousie University, Halifax, Nova Scotia, B3H 4J3, Canada
- 371** SIMULTANEOUS DETERMINATION OF CD, CR, HG IN SEAWEED SAMPLES BY CLOUD POINT EXTRACTION AND NEUTRON ACTIVATION ANALYSIS. Y. Serfor-Armah^{1,2,3}, D. Carbo³, R. K. Akuamoah³, A. Chatt¹. ¹-Trace Analysis Research Centre, Department of Chemistry, Dalhousie University, Halifax, Nova Scotia, B3H 4J3, Canada, ²-Department of Chemistry, Ghana Atomic Energy Commission, P. O. Box LG 80, ³-Department of Chemistry, University of Ghana, P. O. Box 56, Legon-Accra, Ghana
- 405** NEUTRON ENERGY SPECTRUM DETERMINATION AND FLUX MEASUREMENT USING MAXED, GRAVEL, AND MCNP FOR RACE EXPERIMENTS. Taylor Green, Steven Biegalski, Sean O'Kelly, University of Texas

- 388** INVESTIGATION OF CHARGED PARTICLE INDUCED ROUTES FOR PRODUCTION OF ^{100}Pd . F. Tárkányi¹, A. Hermanne², S. Takács³, F. Ditrói¹, J. Csikai^{1,3}, Király B.¹, M. S. Uddin⁴, M. Hagiwara⁴, M. Baba⁴, T. Ido⁴, Yu. N. Shubin⁵, S. F. Kovalev⁵. ¹Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, Hungary, ²Cyclotron Laboratory, Vrije Universiteit Brussel, Brussels, Belgium, ³Institute of Experimental Physics, Debrecen University, Debrecen, Hungary, ⁴Cyclotron and Radioisotope Center, Tohoku University, Sendai, Japan, ⁵Institute of Physics and Power Engineering, Obninsk, Russian Federation,

16-Activation Analysis: Radioanalytical methods and applications to the life sciences

- 113** PROMPT-GAMMA NEUTRON ACTIVATION ANALYSIS SYSTEM DESIGN: EFFECTS OF D-T VERSUS D-D NEUTRON GENERATOR SOURCE SELECTION. Roman J. Shypailo and Kenneth J. Ellis
USDA/ARS Children's Nutrition Research Center Dept. of Pediatrics, Baylor College of Medicine, Houston, TX 77030 USA
- 161** CHARACTERIZATION OF AGING AND THE ETHANOL EFFECTS IN RELATION TO THE MINERALS CONCENTRATION IN BONE SAMPLES BY EDXRF. InayáLima¹, Marcelino Anjos², Monica Rocha³, Ricardo Lopes¹. ¹- Nuclear Instrumentation Laboratory, COPPE, UFRJ, Brazil; ²- Physics Institute, UERJ, Brazil; ³ - Pharmacology Institute, CCS, UFRJ, Brazil.
- 201** NAIL RESPONSE TO SIMULTANEOUS INTAKE OF SE AND HG IN A RAT MODEL. J. D. Brockman,^{1,2} J. D. Robertson,^{1,2} J. S. Morris,² C. Ralston,³ N. Ralston.³ ¹- Department of Chemistry, University of Missouri, Columbia, MO, 65211 ²- University of Missouri Research Reactor, Research Park Drive, Columbia MO 65211 ³- Energy and En
- 211** THE CONDITIONALITY OF SMELLS REFERENCE MATERIALS FOR QC/QA OF K0-NAA IMPLEMENTATION. F. De Corte⁽¹⁾, P. Vermaercke⁽²⁾, P. Robouch⁽³⁾. ⁽¹⁾Laboratory of Analytical Chemistry, Institute for Nuclear Sciences, Ghent University, Proeftuinstraat 86, B-9000 Gent, Belgium; ⁽²⁾SCK-CEN, Mol, Belgium; ⁽³⁾IRMM, Geel, Belgium.

- 226** MINERAL CONTENT OF MEDICINAL PLANTS USED IN URINARY TRACT INFECTIONS. Zohra Lamari, Commena Nuclear Research Center of Draria, Algiers, Algeria, Sheldon Landsberger, Nuclear Engineering Teaching Lab, University of Texas, Austin, Texas, Jon Braisted, Nuclear Engineering Teaching Lab, University of Texas, Austin
- 241** DETERMINATION OF TRACE ELEMENTS IN SCALP HAIR OF AN ELDERLY POPULATION BY NEUTRON ACTIVATION ANALYSIS. M. Saiki (1); O. Jaluul (2); N. M. Sumita(2); W. Jacob-Filho(2) - (1) Instituto de Pesquisas Energéticas e Nucleares (2) Faculdade de Medicina, São Paulo University
- 242** INAA OF ENAMEL AND DENTINE SAMPLES OF A GROUP OF CHILDREN AND ADULTS: A COMPARATIVE STUDY. Marco A. B. Soares, Eduardo M. Adachi, M. Saiki - Instituto de Pesquisas Energéticas e Nucleares- IPEN-CNEN/SP
- 264** THE ONE SOURCE COHORT - EVALUATING THE SUITABILITY OF THE HUMAN TOENAIL AS A MANGANESE BIOMONITOR. Guthrie, James M.; Brockman, John D.; Morris, J.S; Robertson, J.D. University of Missouri Research Reactor.
- 296** CONTAMINATION OF ALPHA-EMITTING IMPURITIES TO HIGH PURITY SILICA FROM PULBERIZING ALUMINA BALL. Kil Yong Lee, Yoon Yeol Yoon, Soo Young Cho, Yongje Kim, Groundwater and Geothermal Division, KIGAM
- 298** ZINC UPTAKE IN SWINE INTESTINAL BRUSH BORDER MEMBRANE VESICLES USING A ZN-65/ZN-69M DUEL ISOTOPE EXPERIMENT. C. E. Buff¹, T. L. Veum², and J. S. Morris¹. ¹University of Missouri Research Reactor Center, Columbia, MO 65211, USA. ²Department of Animal Sciences, University of Missouri-Columbia, Columbia, MO 65211, USA.
- 299** QUALITY CONTROL IN THE NEUTRON ACTIVATION ANALYSIS OF BIOLOGICAL MARKERS FOR SELENIUM IN EPIDEMIOLOGICAL INVESTIGATIONS. J. Steven Morris¹, Ruth Ann Ngwenyama¹, James M. Guthrie^{1,2}, John D. Brockman², Vickie L. Spate¹, J. David Robertson^{1,2}. ¹-University of Missouri Research Reactor Center, Columbia, MO, USA 65211, ²-University of Missouri-Columbia, Department of Chemistry,

- 327** BLACK POPLAR (POPULUS NIGRA L.) BARK AS AN ALTERNATIVE INDICATOR OF URBAN AIR POLLUTION BY HEAVY METALS. Andrey Berizov¹, Oleg Blum², Roy Filby³, Igor Malyuk¹, Volodymyr Tryshyn¹, Yulian Tyutyunnik⁴, 1-INR NASU, Institute for Nuclear Research, Kiev, Ukraine, 2-NBG NASU, National Botanical Garden, Kiev, Ukraine, 3-WSU, Washington State University, Pullman, USA,
- 338** COMPARISON OF TEVA RESIN WITH NEW SOLID EXTRACTANT CONTAINING ALIQUAT 336 FOR DETERMINATION OF RENUUM USING RADIOCHEMICAL NEUTRON ACTIVATION ANALYSIS. Lučaniková Mária^{1,2}, Kučera Jan^{2,3}, Šebesta Ferdinand³ 1-Faculty of Nuclear Sciences and Physical Engineering CTU, Břehová 7, 115 19 Prague 1, Czech Republic 2Nuclear Physics Institute ASCR , 250 68 Řež near Prague, Czech Republic 3Centre for Radioche
- 352** ELEMENTAL ANALYSIS OF HAIR USING PIXE-TOMOGRAPHY AND INAA. D Beasley, I Gomez-Morilla, N. Spyrou. Department of Physics, Centre for Nuclear and Radiation Physics, School of Electronics & Physical Sciences, University of Surrey, Guildford, GU2 7XH, UK
- 363** MONTE CARLO STUDY OF PHOTONEUTRON PRODUCTION IN THE VARIAN CLINAC 2100C LINAC. Andy Ma, University of Surrey, UK; Joseph Awotwi-Pratt, Norfolk and Norwich University Hospital, UK and Nicholas M. Spyrou, University of Surrey, UK
- 365** PROSPECTS OF HIGH ENERGY MEDICAL LINEAR ACCELERATORS IN BNCT, A MONTE CARLO SIMULATION USING VOXELISED PHANTOM. A.Alfuraih,A.MA,A.A. Alghamdi and N.M Spyrou. Department of Physics, University of Surrey, UK
- 370** ACTIVATION ANALYSIS FOR DY, HF, RB, SC AND SE IN SOME GHANAIAN CEREALS AND VEGETABLES USING SHORT-LIVED NUCLEIDES AND COMPTON SUPPRESSION SPECTROMETRY. Facility, Trace Analysis Research Centre, Department of Chemistry, Dalhousie University, Halifax, Nova Scotia, B3H 4J3, Canada. 2Ghana Atomic Energy Commission, P.O. Box LG 80, Legon-Accra, Ghana. 3Physics Department, University of Cape Coast, Cape Coast, Ghana

FNCA2006 研究炉利用ワークショップ [2006年8月28日~9月1日]

首都大学東京大学院理工学研究科 大浦泰嗣

2006年アジア原子力協力フォーラム(FNCA)研究炉利用ワークショップが2006年8月28日から9月1日まで、フィリピン メトロマニラ パッシング市にて開催された。本ワークショップは、研究炉基盤技術、Tc ジェネレータ技術、ならびに筆者が参加した中性子放射化分析の3グループからなる。NAA グループには従来通り、中国、韓国、タイ、ベトナム、インドネシア、マレーシア、フィリピン、日本が参加し、さらに、今回はじめてバングラディッシュがオブザーバーとして参加した。毎年ほぼおなじメンバーが集まるので、再会が楽しみでもある。日本からの参加者は、首都大学東京・海老原先生と大浦の2人である。数年前までは4人参加していたが、予算削減で半数になった。

NAA グループのプロジェクトは、環境試料分析結果の環境行政での有効活用という日本においてはちょっと荷の重いテーマで、socioeconomic な観点に重点をおき、関係各局とコンタクトをとり、放射化分析で得た分析結果を環境行政に役立つようにしていきましょう、というもので、本年度2年目である。これまでは、すべての参加国が大気浮遊粒子(SPM)を環境試料として分析を行ってきたが、昨年からは、各国が自由に試料を選択することとなり、その分析経過と環境行政への取り組みの現状報告がおなわれた。多くの国はSPMを継続して分析を行っていたが、インドネシア、マレーシア、ベトナムは海洋試料(堆積物、生物)の分析を行なった。ベトナムはINAAに加えRNAAも行っており、非常に頼もしく感じられた。活性炭を用いた分離法が興味深かった。我々は、東京都環境科学研究所と国立環境研究所の協力により採集した都心でのPM2.5粒子と沖縄県辺戸岬でのPM10粒子、PM2.5粒子の分析結果を報告した。本稿の最後に、NAAグループの本ワークショップ報告書を転載する。

木曜の午後は、マニラでのSPM採集地点とPhilippine Nuclear Research Institute (PNRI)へのテクニカルツアーがあった。PNRIはかつてTRIGA-II型研究炉PRR-1を運転していたが、冷却水漏れ事故以降運転を停止している。炉室を見学したが、原子炉は燃料棒と冷却水をぬかれ大きな棺桶と化していた。ちなみに、原子炉建屋は白い卵型でとたもかわいらしい。新炉建設の計画があるが、予算難で見通しはよくないらしい。研究炉を利用できないが、PNRIは放射線利用を積極的に推進している。特に、植物の品種改良に成果をあげているようだ。また、啓蒙活動も活発で、啓蒙/教育用マルチメディアCD-ROMをお土産にいただいた。なかなかよくできたCD-ROMでした。PNRIの所長はDela Rosa博士で、華奢な体つきに反して迫力ある話方をされる女性である。本ワークショップに毎年参加しているフィリピン代表は全員女性である。PNRIのパフレット(2004年版)によると責任あるpositionはすべて女性で占められているが、職員の男女比は55:45となっており、男性職員の数が少ないわけではない。少なくとも原子力関連では女性が活躍している国のようである。そういえば、フィリピン大統領も女性ですね。

この時期フィリピンは雨期にあたる。出発直前にPNRIの担当者からずっと雨がふっているから傘を持ってくるようにとの連絡があったのだが、幸いにも滞在中、雨に降られることはほとんどなかった。マニラには巨大ショッピングモールがたくさんある。滞在したホテル(WS会場でもあるのですが)の近くにもSMメガモールはじめいくつかのショッピングセンター(SC)があった。

会議がおわった後(19~21 時ごろ)にでかけるのだが、いつもすごい人出である。SC やホテルの入口にはかならず警備員がいて、金属探知とカバンのチェックが行なわれる。最初の頃は素通りして呼び止められたことが数回。男女それぞれ警備員がいるときは、男は男、女は女というのが暗黙の了解のようである。列が少ないからと女性警備員の方にいったらなんとなく怪訝な顔をされた。その後、よく観察して、このルールに気付いたしである。ちなみに、駅の改札でもチェックがある。B 級グルメを楽しもう(&安上がり)ということで SC のフードコートで夕食を何回か取った。どの SC でもほとんどの店が、肉又は魚とご飯をいっしょにのせた鉄板焼であった。最初に食べた豚のほほ肉をつかったものが大変おいしかったのだが、その後は当りに出会わなかった。ホテルでの食事も特に印象無し。

次回はインドネシアで開催される予定である。食事がおいしかったので楽しみである。

WORKSHOP REPORT

NEUTRON ACTIVATION ANALYSIS (NAA) GROUP MANILA, AUGUST 28-SEPTEMBER 1, 2006

The 2006 FNCA Workshop on Utilization of Research Reactors was held in Manila on August 28 to September 1, 2006. Representatives from nine countries participated in the Neutron Activation Analysis Workshop: Bangladesh, China, Indonesia, Korea, Japan, Malaysia, Philippines, Thailand and Vietnam. Bangladesh was present as an observer.

Dr. Mitsuru Ebihara gave the perspectives for the meeting. The NAA project is now in its second phase. The first phase dealt with the analysis of airborne particulate matter. It had a secondary objective: the introduction of NAA-Ko for the analysis of airborne particulate matter. In the current phase, the participants selected the type of environmental sample to be analyzed by NAA. It has a secondary objective: to demonstrate before national environmental authorities the advantages of NAA for environmental analysis and promote its use in the formulation of environmental policies.

The participants reported on the current status of environmental sample analysis and the reflection of INAA results to environmental authorities. They also presented their respective work plans for 2007. The meeting also discussed possible topics for the third phase of the NAA project.

I. Current Status of environmental sample analysis by NAA

Participants reported on the progress of environmental sample collection and analysis in eight countries. The representative from Bangladesh, which has just joined the Group, reported on current work being undertaken by utilizing INAA.

China

Airborne particulate matter in the PM_{2.5}/PM₁₀ range was collected from Liangxian Town, Beijing using the Gent sampler. Samples were analyzed by k₀-INAA for about 40 elements. Data interpretation has been carried out by using a statistic software, Statgraphics Plus. Four principal factors have been found at the two sampling sites. Correlation among elements was analyzed.

Indonesia

The NAA technique has been used in the monitoring of environmental pollution at North Coastal of Banten Province and the Bay of Jakarta. Marine samples of water, sediments and biota have been collect from 13 sampling points at Banten Province and 33 sampling points of The Bay of Jakarta. Quantitative

analysis has been done by using a standard procedure of k_0 -INAA. Analytical quality control was attained by the use of certified reference materials of NIST 2702 Marine Sediment, NIST 1566b Oyster Tissue and NIST No. 9 Sargasso. The concentrations of interested elements in the water and sediment samples were determined and are presented in this workshop. The results of analytical quality control of k_0 -INAA by using k_0 -IAEA software have been also reported and discussed.

Japan

PM10 particulate matters (coarse and fine fractions) have been collecting in Hachioji and Sakata in Phase-II and samples are analyzed by k_0 -INAA. In addition to collecting PM10, collecting PM2.5 particulates at Koto, in downtown Tokyo, was started on April, 2006 in cooperation with Tokyo Metropolitan Research Institute for Environmental Protection. SPM concentration and almost elemental concentrations of SPM in Hachioji and Koto was not so different each other during April to July, 2006. In Koto Mn concentrations were two time higher than in Hachioji. Cape Hedo in Okinawa is also a new sampling site. PM10 and PM2.5 particulates were collected tentatively in cooperation with National Institute for Environmental Studies. Elemental concentrations for V, Mn, Cu, Br, and I were lower than average concentrations in Sakata, rural site in Phase I.

Korea

Air particulates ($< 2.5 \mu\text{m}$ EAD, PM_{2.5}) were collected at Chungnam National University in Daejeon city in the Republic of Korea. An annular denuder air sampler and polycarbonate membrane filters were used for the collection of PM_{2.5}. Sixty samples were collected from August 2005 to March 2006. Mass concentration of PM_{2.5} was determined by the sampling dates. Twenty eight elements including Al, As, Cr, Mn, etc., were analyzed by using INAA and the concentration of the measured elements could be determined. In addition, the black carbon concentration was measured by the reflectance method. The mean value of mass concentration and the ratio of black carbon of PM_{2.5} were $31.6 \mu\text{g}/\text{m}^3$ and about 18%, respectively.

Malaysia

Trace and toxic elements were determined in marine sediments collected from the Strait of Malacca, Malaysia. Samples are collected at 18 sampling locations at the Strait of Malacca. Results show that toxic elements namely As, Sb, V and Zn were relatively high in some sampling location. Major contributing sources of these toxic elements are from anthropogenic activities within the sampling area. The outcome of this project is to provide information regarding the recent status of trace and toxic element concentration presence in the marine sediment collected from the sampling location at the Strait of Malacca. This information is vital in the understanding the pollution level at the Strait and hence a proper control measures may be taken by the relevant authority to control the level of pollution and to protect the natural environment of the Strait of Malacca.

Philippines

The Philippine station for the FNCA project is located at Valenzuela, an industrial area in Metro Manila. This is one of two stations operated by the PNRI in Metro Manila which is co-located with an Environmental Management Bureau real-time monitoring station. Annual summary data for PM2.2 and PM10 for 2004 and 2005 indicate significant increase in concentration for 2005. Multielement characterization of air filters is performed by secondary target XRF spectrometry. Peaks in concentration of some elements on certain days as seen in time series charts indicate association among elements and can provide information on the contributing pollutant source. The availability of trace element data from NAA is useful in verifying results of source apportionment or identifying the cause of abnormal events leading to peaks in concentration observed on particular days. is useful in determining the source of pollution. Technical cooperation among a regional scientific community such as FNCA will enhance acceptability of nuclear analytical techniques in the region.

Thailand

An air pollution study of Saraburi Province, Thailand was presented. The area has been facing difficulties due to high dust generating industries. The work is done under a contract agreement with the Pollution Control Department, Ministry of Natural Resources and Environment. The elemental composition of SPMs, soils and fly ash in Saraburi Province are being monitored. The samples were collected quarterly from May 2005 to March 2006. The average weight of SPM was found lowest in wet

season and highest in the middle of dry season. The analytical techniques use for elemental analysis is Wavelength Dispersive X-ray Fluorescence. The elements found are Na, Mg, Al, As, Sr, Br, Si, P, S, Cl, K, Ca, Ti, V, Mn, Fe, Co, Cu, and Zn. Calcium is selected as the key elements since most postulated source of pollution is due industrial utilization of the limestone deposit.

Vietnam

Samples were collected from the coastal area of Nhatrang and Ganhrai bay. Sampling and sample preparation techniques for major, minor and trace elemental analysis in marine environmental samples have been investigated and some preliminary work on sample analysis has been performed. More than 20 elements in marine environmental samples in Nhatrang and Ganhrai bay could be measured. It indicates that both INAA and Radiochemical Neutron Activation Analysis (RNAA) methods can be used for the determination of elements in sediment, seawater and biota samples by directly or after sample treatment for chemical separation either volume reduction or preconcentration.

Bangladesh (Observer)

Arsenic concentrations in human hair samples of a highly polluted site namely Boro Dudpalila village, Damurhuda, Chuadanga and nonpolluted sites of Goainghat & Sylhet Sadar thanas were determined using instrumental neutron activation analysis (INAA) technique. Samples were irradiated in the TRIGA Mark-II research reactor of Atomic Energy Research Establishment (AERE), Savar, Dhaka, Bangladesh and PARR-2 of Pakistan Institute of Nuclear Science & Technology (PINSTECH), Islamabad, Pakistan at a thermal neutron flux of order 10^{12} n/cm²/s for 3 hours. Ranges of arsenic concentrations in Chuadanga and Sylhet samples were found to be 1.04 ± 0.06 to 48.66 ± 1.32 and <0.20 to 0.84 ± 0.04 ppm, respectively. Minimum detection limit of arsenic in the hair samples was found to be 0.20 ppm. All Chuadanga samples exceeded the normal level of arsenic in human hair (1 ppm). In the study it was found that both males and females are affected and there was generally no consistency in the arsenic levels in hair of the members of the same family.

II. Reflection of INAA data to environmental authorities

All the participants are doing environmental sampling and applying NAA for analysis for use of varied end-users e.g. national and regional environmental offices, the scientific community, international development organizations concerned with sustainability of the environment. The manner and extent by which data are made available to policy makers varies among countries depending on the degree of development of the institutions for environmental management. Participants have initiated moves to establish direct or indirect link-up with end-users of data, including national government authorities. A number of participants have formal collaboration with national and regional environmental ministries for the application of INAA in studies in support of policies for the environment.

China

The present work is being implemented under contract with the Environmental Protection Bureau of Fangshan District. The implementation of air pollution study by using NAA and related techniques helps the local government in the investment for improving the quality of environment.

Indonesia

The present project is being carried out in cooperation with the local environment administration of DKI Jakarta and Banten Province for the management of the marine environment. The study aims to map out the heavy metal concentration at the Jakarta Bay and determine the distribution of heavy metals at different compartments of the environment.

Japan

Two joint works with scientists of the National Institute of Environmental Sciences, which belongs to the Ministry of Environment, have been conducted; air monitoring at Okinawa and NAA of SPM reference sample. Results will be reflected to the administrative policy for protecting pollutants under the authority of the Ministry of Environment.

Korea

Air monitoring in Daejeon has been carried out in collaboration with the Chungnam National University as research and development projects supported from Ministry of Science and Technology and

from Ministry of Environment.

Malaysia

The Atomic Energy Licensing Board is funding its marine pollution project utilizing INAA due to its advantages reliability in the analysis of various samples. More time is required so that the INAA technique will eventually appeal to the environmental administration in Malaysia and may find this technique useful for their analytical requirements.

Philippines

The Philippine Nuclear Research Institute has ongoing collaboration with the Environmental Management Bureau in various areas of environment. It has served in Technical Working Groups organized by the EMB. Two of its stations are co-located with EMB air monitoring stations. The PNRI contributed data to the 2002 and 2003-2004 National Air Quality Status Report. A contract for PM10/PM2.2 monitoring at a new site in Davao City Mindanao has just been finalized with the USAID Energy and Clean Air Project.

Thailand

The data is being utilized by the Air Quality and Noise Management Bureau, Pollution Control Department, Ministry of Natural Resources and Environment, the environmental authority in Thailand under an official agreement. The authority will use this data to find possible solution for air quality improvement of the area. This project demonstrated the close collaboration on the recognition on the effective utilization of nuclear analytical techniques by the environmental authority in Thailand. This is expected to lead to stronger future collaboration between the two parties..

Vietnam

Dalat Nuclear Research Reactor with thermal power of 500 kW has become a scientific facility for carrying out NAA. During the past two decades, based on NAA methods in combination with other analytical techniques, Dalat Nuclear Research Institute (DNRI) has carried out many programs such as: National Research and Development Programs, Co-ordinated Research Projects with other organizations in Vietnam.

III Work Plan for 2007

Several countries will continue present work identified in the work plan spelled out in 2005. (Indonesia, Japan, Korea, Malaysia, Philippines, Vietnam.) Bangladesh, which has just joined the project will apply INAA for the analysis of water, soil, rice, vegetables, human hair samples, industrial waste, diet samples as indicators of the levels of As pollution. China will participate in the analysis of vegetables, human hair, fruit, oysters samples for use as certified environmental reference materials. In addition to the present work, Japan will collaborate with NIES scientists in air pollution studies, particularly in air monitoring at Hedo, Okinawa. It will also participate in the preparation of manual for SPM analysis where INAA can be included. It will make representation with the NIES for inclusion of participants of the NAA project in the round-robin exercise being planned for 2007. Thailand will undertake a new project involving the monitoring of sediment and biota at Thalenoi Bay, a marine reserve.

IV. Other matters

1. Report for the First Phase of the Project

So far only 2 countries have submitted the Report for the First Phase of the Project on air particulate analysis, covering 2002-2004 (Indonesia and Malaysia). Many countries reported that work is in progress. A new deadline was set for the submission of the report to Prof. Ebihara, the end of October 2006.

2. Project database

The project database from the participating countries has been compiled by Mr. Wee Boon Siong (Malaysia) and is ready for uploading at the FNCA web site. A chart containing annual means for each country was prepared. There were comments regarding the plan to have free access to the web site including download of raw data. It was agreed that an additional control would be instituted - user registration for

those who wish to download data.

3. Assigned tasks

Of the assigned tasks, only the common paper on airborne particulate matter was completed. A paper "Collaborative monitoring study of airborne particulate matters among seven Asian Countries" by M. Ebihara, Y. S. Chung, W. Chueinta, B. F. Ni, T. Otoshi, Y. Oura, F. L. Santos, F. Sasajima, Sutisna and A. K. B. H. Wood, was accepted for publication in the Journal of Radioanalytical and Nuclear Chemistry, Vol. 269, No. 2 (2006). Another publication is in preparation and is expected to be completed at the end of November, 2006).

The following tasks have not been completed:

- Paper on the comparison of SPM data between INAA and XRF (F. L. Santos & Y. Oura).
- QA/QC on INAA for small samples (W. Chueinta) –
- Comparison of NAA data from different ko software (Ho. M. D.)

Delay in the comparison of XRF and INAA was due to breakdown of the PNRI XRF spectrometer which prevented further validation of analysis. With completion of analysis of CRM for air particulate matter on air filter, it is believed that there is now sufficient basis for completing the paper. A new deadline has been set, the end of November, 2006. For the 2 remaining tasks, the responsible persons were not present at the meeting. Information on their status will be obtained.

V. Future Plans for Third Phase of the Project

After extensive discussion, the group agreed that NAA is one of the major research reactor utilization in each country. NAA has greater elemental coverage than other analytical techniques and data have had great impact in environment, health, agriculture, material science, etc. It is believed that it could be an effective tool to promote socio-economic benefits in the region. The group strongly recommends the continuation of the project after the termination of the present program in March 2008. Possible areas of study for the third phase of the project are the following:

1. Prompt gamma neutron activation analysis
2. RNAA which can provide data not possible with INAA
3. Forensics
4. Food safety and nutrition
5. Archeology and art
6. Environment and health

2006 日本放射化学会年会・第50回放射化学討論会 記念大会

[2006年10月24日～27日]

東京大学大学院総合文化研究科 松尾基之

標記学会が2006年10月24日(火)～27日(金)に開催されました。今年は、放射化学討論会としてはめでたく第50回を迎え、記念大会として会期も4日間に延長して行われました。前半の2日間は水戸市常陽藝文センター、後半の2日間は日本原子力研究開発機構原子力科学研究所を会場にして、吉田善行先生(原子力機構)のお世話のもとで開催されました。

初日の午前中は、初代日本放射化学会会長の中原弘道先生(都立大名誉教授)の基調講演を皮

切りに公開講演が4件それに続き、昼食を挟んで、西先生追悼式典が行われました。その後、A、B会場に分かれて一般講演に移りました。2日目は、午前中の一般講演のあと、午後からは50周年記念講演3件、特別講演1件が行われました。その後、永年にわたり放射化学に貢献されてきた斎藤信房先生の特別表彰・講演があり、顕彰式が厳かに行われました。3日目からは会場を原子力科学研究所に移し、ASR2006との共同開催という形になりました。また、J-PARKの見学会が、3日目は英語、4日目は日本語にて行われました。講演数は、上記の基調講演等と、学会賞・奨励賞受賞講演3件、口頭発表48件、ポスター発表90件を合わせて、151件でした。

放射化分析分科会は、初日の18:45から開催されました。第1部では、原子力機構の施設共用利用体制と即発 γ 線分析を中心とした産業利用の取組みについて原子力機構の笹島氏と松江氏により紹介がありました。第2部では、放射化分析研究会の会計報告に続き、京大原子炉、住重試験検査株式会社、原子力機構の放射線標準施設等の紹介があり、海老原氏よりMTAA-12の準備状況の説明がありました。なお、詳細な議事録は本誌に別掲されています。

放射化分析に関連した発表は21件あり、今年の9件、一昨年の17件を大きく上回る勢いでした。以下に、発表のリストを挙げます。

◎ 公開講演

1S04 中性子利用元素分析の今後の展開と宇宙化学への応用

(首都大院理工) 海老原充

◎ 口頭発表

1A04 前濃縮中性子放射化分析による岩石試料中の微量親鉄性元素の定量

(首都大院理工) ○田中奈津子、大浦泰嗣、海老原充

1A05 k_0 標準化法を用いた中性子放射化分析(II)

(首都大院理工) ○大浦泰嗣、海老原充

1A06 放射化分析法およびXAFS法による遠洋性海洋堆積物中のMn分析

(東大院総合、東大海洋研) ○小豆川勝見、佐野有司、松尾基之

1A07 即発 γ 線を用いた2次元元素分布測定システムの開発

(原子力機構、放振協、高エネ研) ○瀬川麻里子、松江秀明、関谷祐二、山田悟、篠原武尚、奥隆之、笹尾一、鈴木淳市、清水裕彦

1A08 多重ガンマ線検出法を用いた中性子放射化分析法による日本刀中の微量元素の定量

(武蔵工大工、原子力機構) ○岡田往子、平井昭司、大谷眞一、木村敦、藤暢輔、初川雄一、小泉光生、大島真澄

1A09 荷電粒子放射化分析によるシリコン半導体中の 10^{-14}cm^{-3} レベルの窒素濃度評価法の検討

(住重試験検査、KEK、武蔵大、ピュアレックス、JRIA、大阪府大) ○八木宏親、榎本和義、葉袋佳孝、野崎正、斎藤義弘、井上直久

1A13 東京と八丈島における大気エアロゾル中の ^7Be ・ ^{10}Be 濃度の季節変動

(日大院総合基、日大文理、東大院工) ○山形武靖、齊藤敬、松崎浩之、永井尚生

2A05 KENS高エネルギー中性子遮蔽実験

(高エネ研、米国フェルミラボ、清水建設、東大院理学系、日大院総合基礎、中国高能研) ○松村宏、中尾徳晶、榎本和義、大石晃嗣、川合将義、阿瀬貴博、豊田晃弘、沼尻正晴、高橋一智、藤村匡胤、王慶斌、別所光太郎、佐波俊哉

- 2A06 高エネルギー陽子加速器のマグネット冷却水中に生成する⁷Be,¹¹C の化学挙動
(高エネ研) ○別所光太郎、千田朝子、松村宏、穂積憲一、三浦太一、榎本和義
- ◎ ポスター発表
- 3P01 宮城県産養殖マガキ軟体部の多元素分析
(石巻専修大理工、京大炉、ダルハウジー大) ○福島美智子、中野幸廣、アマレスチャット
- 3P02 超音波を用いた溶媒抽出法によるリョウブ葉内のコバルトの分布に関する研究
(北大アイソ総セ、愛県大情報、北大植物園) ○笠原茂、前川路子、野矢洋一、小栗宏次、大野祥子、関興一
- 3P03 亜鉛欠乏マウスのすい臓細胞中における微量元素濃度の定量
(静岡大理) ○川島美智子、上島淳慈、衣川信之、松下和馬、皆吉龍二、野口基子、菅沼英夫、矢永誠人
- 3P05 放射化分析法およびメスバウアー分光法による干潟底質の環境評価
(東大院総合) ○諸町大地、久野章仁、松尾基之
- 3P06 土壌・底質中の有機態ハロゲン(EOX)の機器中性子放射化分析と個別有機ハロゲン化合物のGC-MS分析
(愛媛大農、Gdansk 大) ○河野公栄、北村清司、J. Falandysz
- 3P07 多重ガンマ線放射化分析法によるプレソーラーグレインの研究
(原子力機構) ○初川雄一、宮本ユタカ、藤暢輔、大島真澄、早川岳人
- 3P08 多重 γ 線測定を利用したINAAによる海水中微量元素定量の試み
(東大院新領域、首都大院理工) ○高田雄一郎、大浦泰嗣、海老原充
- 3P09 アクチバブルレーザーの核医学応用への基礎的検討
(金沢大院医) ○鷲山幸信、天野良平
- 3P12 徳島大学における自己遮蔽型PETサイクロトロンでの箔放射化法による漏洩中性子線の測定
(徳島大医、徳島大アイソトープ、住重試験、住友重機、徳島大病院、徳島大総科) ○阪間稔、佐瀬卓也、坂根仁、前田幸志、三好弘一、西谷弘、佐藤一雄、前田恵理子、本田朋子、川口佳彦、中山信太郎
- 3P13 セレン欠乏酸化ストレスと生体内微量元素動態
(昭和薬大) 佐久間泰亘、露木聡史、長山敦子、松岡圭介、本田智香子、○遠藤和豊
- 4P32 主成分分析とトラジェクトリ解析によるエアロゾル粒子発生源の季節変動
(九大院理) ○森長一朗、杉原真司、前田米蔵

施設便り

原子力機構施設共同利用研究

—東京大学大学院工学系研究科原子力専攻共同利用管理本部（大学開放研究室）—

- 平成 19 年度原子力機構施設共同利用研究の課題公募は平成 18 年 10 月 31 日をもって締め切られました。応募された研究課題は翌年 1 月に開催予定の原子力機構施設利用共同研究委員会において課題採択の可否の検討が行われ、3 月下旬頃に採択通知をご報告致します。

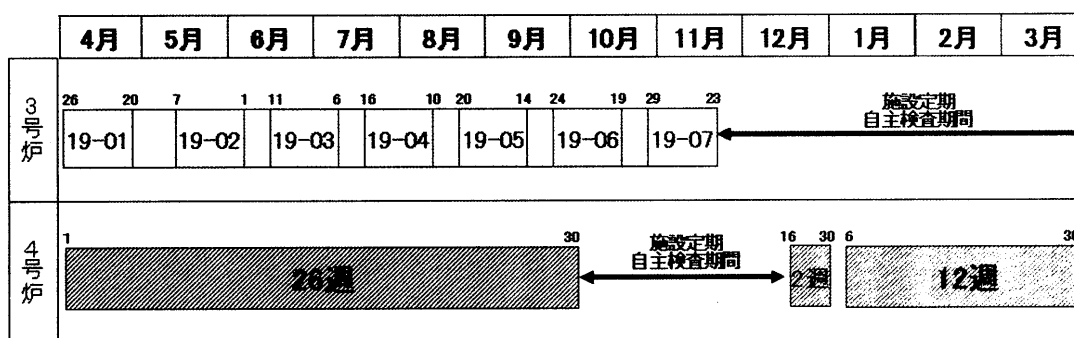
平成 19 年度の研究課題として応募された件数は下記の通りです。

- ・一般共同研究 81 件 前年度比 5.8%減 (前年度応募件数 86 件)

- 平成 19 年度より JRR-3 は 3 年間で 1 回の高経年化対策を実施することとし、7 サイクル運転、7 サイクル運転、6 サイクル運転を 3 年周期で繰り返す運転計画となる案が出されています。JRR-4 についても 5 年間で 1 回、高経年化対策を実施する予定となっています。これは施設定期自主検査の間隔を延長し、節約した費用を高経年化対策に当てると云う計画です。また、JRR-3 と JRR-4 がなるべく同時には停止しないように配慮した平成 19 年度の運転計画が公表されましたので下記に示します。

JRR-3, JRR-4 平成19年度運転計画(案)

(3号炉) (4号炉)

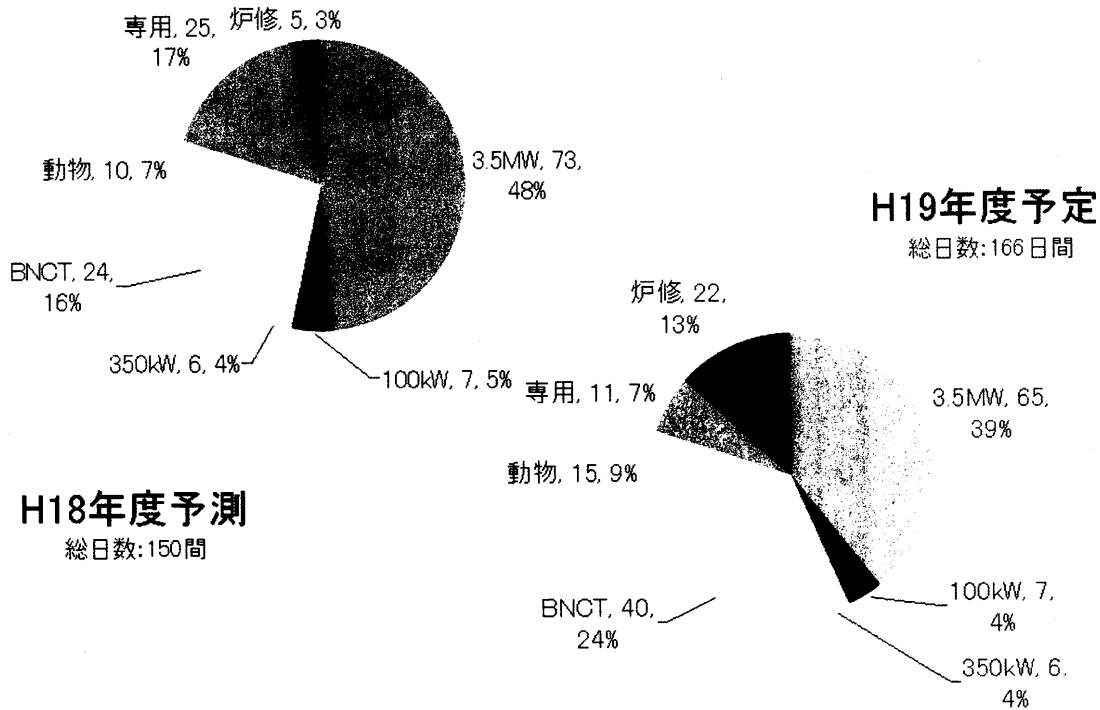


- JRR-4 は人材育成のための利用ニーズの増大もあり、一般炉内照射利用は全体の運転計画の半分以下となる事が予想されます。(下図参照) また、平成 18 年度からの京都大学原子炉実験所(KUR)の休止、さらには分野の活性化に伴い、JRR-4 を利用する医療照射や動物照射の件数が増加しました(医療照射は前年度 5 件増)。その結果、JRR-4 を利用した炉内照射利用及び付属の実験室を利用した実験利用の件数が昨年度と比較して減少傾向にあります。以上の理由から今後は JRR-4 を利用した照射・実験利用は利用日の制限などが懸念されます。共同利用管理本部では、これらの問題に対して原子力機構と検討を続けてまいります。

用者の皆様方には、これまで以上に効率的な利用を心掛けて頂きますようご協力をお願い致します。

JRR-4_運転計画の推移

表記: カテゴリー, 日数, 割合



(澤幡浩之)

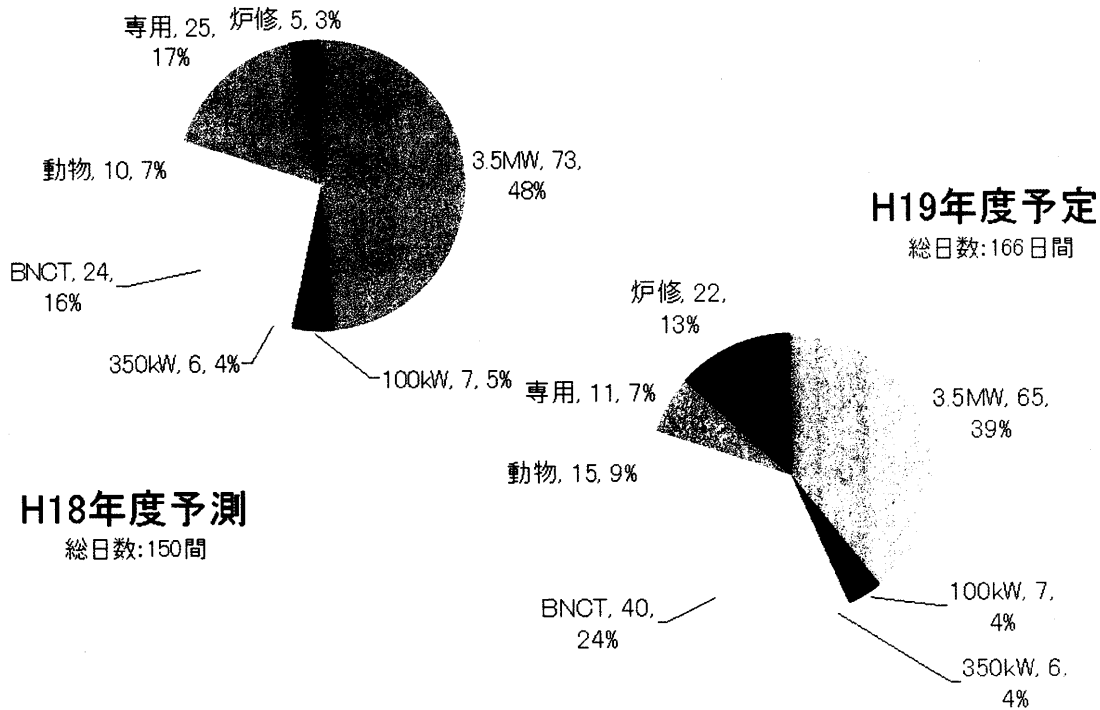
京都大学原子炉実験所

KURが運転を休止して8ヶ月が経ちますが、京大炉ではKURの再開に向けて様々な準備が進められております。燃料の低濃縮化に関しては、関係省庁におけるヒアリングが年内に終了し、新燃料の製造および平成20年度の運転再開に向けて着々と作業が進んでいます。また放射化分析のために用いられる圧気輸送管照射設備 (Pn-1, -2, -3 および Tc-Pn) の制御系改良計画も進められており、予算の目処もつき具体的な改良作業が始まろうとしています。この改良計画に関しては利用者からの要望を可能な限り取り入れたいと思いますので、これまでの利用者の方や今後利用を計画されている方からの要望・提案をお待ちしております。KUR休止期間中の韓国原子力研究所のHANAROを利用した放射化分析に関する共同利用プロジェクトでは、7月に3グループ(7人)の実験者がHANAROを訪れて放射化分析実験を行いました。その後、保守および工事のため8月から11月まで休止期間を設け、12月から運転再開の予定でしたが、工事の遅れのため平成19年1月からの再開となりました。また、平成19年度も引き続きHANARO共同利用実験を行います。平成18年度同様に8月から11月の間が保守および工事期

用者の皆様方には、これまで以上に効率的な利用を心掛けて頂きますようご協力をお願い致します。

JRR-4_運転計画の推移

表記: カテゴリー, 日数, 割合



(澤幡浩之)

京都大学原子炉実験所

KURが運転を休止して8ヶ月が経ちますが、京大炉ではKURの再開に向けて様々な準備が進められております。燃料の低濃縮化に関しては、関係省庁におけるヒアリングが年内に終了し、新燃料の製造および平成20年度の運転再開に向けて着々と作業が進んでいます。また放射化分析のために用いられる圧気輸送管照射設備 (Pn-1, -2, -3 および Tc-Pn) の制御系改良計画も進められており、予算の目処もつき具体的な改良作業が始まろうとしています。この改良計画に関しては利用者からの要望を可能な限り取り入れたいと思いますので、これまでの利用者の方や今後利用を計画されている方からの要望・提案をお待ちしております。KUR休止期間中の韓国原子力研究所のHANAROを利用した放射化分析に関する共同利用プロジェクトでは、7月に3グループ (7人) の実験者がHANAROを訪れて放射化分析実験を行いました。その後、保守および工事のため8月から11月まで休止期間を設け、12月から運転再開の予定でしたが、工事の遅れのため平成19年1月からの再開となりました。また、平成19年度も引き続きHANARO共同利用実験を行います。平成18年度同様に8月から11月の間が保守および工事期

間に割り当てられているようです。共同利用実験者の方々にはご迷惑をお掛けしますが、短い期間で可能な限りの成果をあげたいと思います。

(高宮幸一)

東北大学原子核理学研究施設

平成18年度後期の採択課題

課題番号	代表者	所属	研究テーマ
2582	大槻 勤	核理研	標識化による金属内包フラーレン及びヘテロフラーレンの製造及びその応用研究
2583	中西 孝	金沢大・自	光核分裂反応断面積の実測値と計算値の比較
2584	鹿野 弘二	函館高専	光量子放射化分析法による光通信用材料中の不純物評価
2585	大浦 泰嗣	首都大・理工	宇宙化学的試料及び環境試料の光量子放射化分析
2586	鈴木 達也	東工大・原子炉研	固体抽出剤を用いた希土類元素とアクチノイド元素の分離に関する研究

放射性同位元素の製造、光量子放射化分析に威力を発揮する施設です。

皆様の課題申し込みをお待ちしています。

(大槻勤)

間に割り当てられているようです。共同利用実験者の方々にはご迷惑をお掛けしますが、短い期間で可能な限りの成果をあげたいと思います。

(高宮幸一)

東北大学原子核理学研究施設

平成18年度後期の採択課題

課題番号	代表者	所属	研究テーマ
2582	大槻 勤	核理研	標識化による金属内包フラーレン及びヘテロフラーレンの製造及びその応用研究
2583	中西 孝	金沢大・自	光核分裂反応断面積の実測値と計算値の比較
2584	鹿野 弘二	函館高専	光量子放射化分析法による光通信用材料中の不純物評価
2585	大浦 泰嗣	首都大・理工	宇宙化学的試料及び環境試料の光量子放射化分析
2586	鈴木 達也	東工大・原子炉研	固体抽出剤を用いた希土類元素とアクチノイド元素の分離に関する研究

放射性同位元素の製造、光量子放射化分析に威力を発揮する施設です。
皆様の課題申し込みをお待ちしています。

(大槻勤)

事務局より

◇平成 18 年度放射化分析研究会拡大幹事会議事録

日時: 平成 18 年 7 月 12 日

場所: 東京大学タンデム加速器棟会議室

参加者: 海老原充, 大浦泰嗣, 河野公栄, 木川田喜一, 澤幡浩之, 福島美智子, 榎本和義, 松尾基之, 村松康行

1. 報告

- ・平成 18-19 年度幹事選挙結果

新幹事: 大浦泰嗣(首都大), 岡田往子(武蔵工大), 高宮幸一(京大), 榎本和義(KEK), 松江秀明(JAEA), 松尾基之(東大)

継続幹事: 海老原充(首都大), 河野公栄(愛媛大), 木川田喜一(上智大), 澤幡浩之(東大), 宮本ユタカ(JAEA)

- ・放射化分析 No.20 は印刷中

2. 議題

(1) 会誌の編集体制の変更について

編集委員会規定を作成し、編集体制を整える、体制としては編集長の下に複数の編集委員を置き(編集長以外に 3 名程度)、編集委員会を幹事会の外に配置する。編集長の任命は幹事会で行う(選挙?), 編集長候補者は必ずしもそのときの幹事であることを要しない。編集委員は、編集長が会員の中から選び、幹事会です承する。印刷・発送は編集委員会の責任で行う。

初代編集長は大浦泰嗣とする。編集長は委員を選出し、メールにて幹事に連絡する。また、編集委員会規定を作成する。

(2) 選挙制度の変更について

規定をつくって刷新する。次回の拡大幹事会で議論し、案を作り次年度以降に適用する。具体的には、従来の代表幹事を中心とする選挙制度を廃止し、独立の選挙管理委員会を設置して選挙を行う方向で検討する。

次回幹事会で詳細を議論する。

(3) 役割分担

代表: 海老原

企画: 松江(放射化学討論会), 高宮(京大原子炉専門研究会)

ホームページ: 榎本、大浦、澤幡、笹島、宮本

編集: 大浦、宮本、岡田、河野

庶務(会員管理): 澤幡、河野、木川田

会計: 澤幡

監事: 松尾

(4)会計報告

平成 17 年度収支決算について報告、異議なく承認された。併せて会員構成と会員数の推移に関する報告があり、了承された。

(5)その他

会誌に関する企画

外国の研究炉の特集——外国の研究者に原稿執筆を依頼する

No.19 韓国、No.インドネシア?、No.21 中国炉

新規会員の発掘。KUR 学術報告会で広報する。広報用パンフレット作成を福島美智子氏に依頼。

会費未払者対策を考える。河野幹事に依頼。

次回の幹事会は総会の前に開催すべき。

◇第 50 回放射化学討論会 放射化分析分科会報告

開催日時：平成 18 年 10 月 24 日（金） 19:00～21:00

開催場所：水戸常陽藝文センター A 会場

参加者：約 30 名

世話人：原子力機構 松江秀明、初川雄一

議事内容：

平成 18 年度の放射化分析分科会は、第 50 回放射化学討論会記念大会所初日に当日の強風による常磐線の遅れによる討論会の遅延の影響もあって、当初の予定に 15 分ほど遅れて 19 時から開催された。

第 1 部

第一部は、日本原子力研究所が改組され日本原子力研究開発機構がスタートして一年あまり経過して、中性子の外部利用の対する原子力機構の姿勢とシステムが変更されたこの機会に、ここ一年の原子力機構の施設共用利用と中性子の産業利用に関する取組みについての二つの講演を中心にお弁当を食べつつ行われた。まず原子力機構の笹島氏より「原子力機構の放射化分析関連の施設共用利用について」と題して、原子力機構における放射化分析関連の施設共用利用（参考：<http://www3.tokai-sc.jaea.go.jp/sangaku/>）についての紹介があった。引き続き、松江が「中性子産業利用の取組みについて—即発 γ 線分析における中性子利用技術移転推進プログラムを中心に」と題して、即発 γ 線分析装置の最近の集光ビームの導入やパルス中性子利用などのトピックスと PGA の産業利用の取組みについて、今年度より開始された中性子利用技術移転推進プログラム（通称：トライアルユース）等の紹介を中心に講演を行った。トライアルユースは、民間の方の中性子利用の呼び水的なプログラムであり、中性子が役に立ちそうな案件のある民間企業の

方にまずは中性子を利用していただくというものである。今年度は延べ 15 件の申請があり、24 回の PGA 実験が行われた。本プログラムは来年度も実施され、(財)放射線利用振興協会のホームページ (<http://www.rada.or.jp/>) を通じて来年の 2 月ごろに課題の募集の案内が掲示される予定である。応募資格は原子力施設立地地域の公共団体、企業、公的研究機関の職員等であるが有資格者は大学の研究者の協力を仰ぐことも可能であり、また、原子力施設立地地域以外の希望者も茨城県中性子利用促進研究会 (<http://www.sf21-ibaraki.jp/index.html>) の分科会である非破壊分析・可視化研究会のモデル実験を通じて参加することも可能である。

これら二つの講演をタネにして、原子力機構の施設利用や中性子利用のあり方について、「トライアルユースの成果公開のあり方」や「放射化分析の標準物質の値付け分析へ積極的にアプローチすべき」等などの率直で本質的な質疑応答が展開された。

第 2 部

第二部は「放射化分析研究会からのお知らせ」とそれに関連する質疑応答が行われた。

内容は下記の通りである。

1. 放射化分析研究会会計報告 愛媛大学の河野幹事より 2005 年度の会計報告が行われ、出席者の了承が得られた。また、研究会の会員数の推移等の報告もあった。
2. 京大炉の高宮幸一先生から KUR の今後の動向及び韓国原子力研究所の研究炉 HANARO の共同利用の話題を頂いた。
3. 住重試験検査(株)の八木氏より 住重試験検査(株)の放射化分析サービスの紹介があった。来年度以降は、原子力機構の研究炉を利用した即発 γ 線分析、中性子ラジオグラフィ、中性子放射化分析の分析サービスの導入も検討していると報告があった。
4. 原子力機構の瀬川氏より原子力機構の放射線標準施設 (<http://www3.tokai-sc.jaea.go.jp/sangaku/3-facility/05-support/index-116.html>) のペネトロン加速器の利用に向けた話題の報告があった。原子力機構は研究炉等の外部利用可能施設だけではなく、従来内部の利用のみであった施設も積極的に公開していく方針であり、このペネトロン加速器もその一環として外部利用者が可能となったものである。
5. 原子力機構の初川氏より、MPGA 等の現状報告があった。
6. 海老原代表幹事より MTAA12 の招致状況と準備活動の報告があった。
7. その他、京大炉の柴田先生より京都大学原子炉実験所専門研究会(「放射化分析法利用に関する国際化専門研究会」(<http://www.rri.kyoto-u.ac.jp/index/gyoji.html>))が 12 月 22 日(金)に、放射化分析研究会「冬の学校」をかねて行われる予定であるとの報告があった。

分科会は、予定の 20:15 を過ぎて、21 時近くになって閉会した。なお、平成 19 年度の放射化分析分科会の世話人は、静岡大学の矢永氏が引受けて下さることになった。第 51 回放射化学討論会は、9 月 16-21 日の MTAA-12@八王子に引き続き 9 月 24-26 日に静岡市で開催される予定である。

(報告者 松江秀明)

◇放射化分析冬の学校(京大炉専門研究会)

平成 18 年 11 月 10 日

放射化分析研究会 会員各位

専門研究会世話人

人間環境大学 片山幸士 (所外)
京都大学原子炉実験所 柴田誠一 (所内)

京都大学原子炉実験所専門研究会のご案内
(放射化分析法利用に関する国際化)

京大原子炉は本年度より運転を中止し、約 2 年間休止の後再開が予定されています。休止期間の対応もかねて韓国の HANARO 共同研究利用が募集されました。

そこで、本年度は、放射化分析研究の国際化に向けてどのように発展させていけばよいかアジアの研究炉の現況紹介、HANARO での共同利用実験の進行状況、また、KUR の運転再開へ向けての取り組みや原研施設の利用状況などを議題として取り上げることにしました。

また、来年 9 月には MTAA-12 が首都大学東京で開催されます。そこで午後は MTAA-12 の組織委員会からの準備の状況報告と討論とさせていただきます。

今年度は下記のプログラム(案)にしたがって研究会を開催いたしますので、ご参加をお待ちしております。特に MTAA-12 の組織委員の方は、是非ご出席ください。

なお、この専門研究会を放射化分析研究会「冬の学校」の活動の一部といたします。

プログラム(案)

日 時：平成 18 年 12 月 21 日(木) 集合、宿泊

12 月 22 日(金) 9 時 30 分-12 時 30 分

場 所：京都大学原子炉実験所原子力科学館(実験所正門から歩いて約 10 分) 会議室

宿 泊：京都大学原子炉実験所 共同研究員宿舎

12 月 22 日(金)

午前(9:30 - 12:00)

1. KUR の運転再開へ向けての現況(京大炉 柴田)
2. アジアの研究炉の現況紹介(首都大 大浦)
3. HANARO での共同利用実験の進行状況(京大炉 高宮)
4. HANARO での放射化分析(京大炉 関本)
5. 原研炉(東大 澤幡)

午後 (13:00 - 15:00)

MTAA12 の準備状況

参加申込期限：11月24日(金)

(事務手続き上、できるだけ早くお申し込みください)

申込は、このメールを返信にしないで、必ず「katayama@uhe.ac.jp」宛お送りください。

(このご案内は、メーリングリストを使用しておりますので、このまま返信していただくと全員に送信されます)

申込先：

〒444-3505

愛知県岡崎市本宿町上三本松 6-2

人間環境大学

片山幸士

TEL/FAX: 0564-48-1014

E-mail: katayama@uhe.ac.jp

携帯: 090-2288-2090

----- 参加申込書 -----

氏名：

所属：

職名：

級号俸：

連絡先：住所（郵便番号）

E-mail

TEL

FAX

自宅：住所（郵便番号）

宿泊： 12月 21日 要 不要 (どちらか残してください)

昼食（寿司弁当）22日： 要 不要 (どちらか残してください)

問い合わせ先：

片山幸士

TEL/FAX: 0564-48-1014

携帯: 090-2288-2090

E-mail: katayama@uhe.ac.jp

青木 達

TEL/FAX: 0774-23-8490

E-mail: aokitoru@kd6.so-net.ne.jp

(メーリングリストより転載)

MTAA-12 準備状況

MTAA-12 ホームページ: <http://www.mtaa12.com>

- ・ 第 3 回組織委員会 (2006/7/12)
議題: 委員会組織, 業務委託, 今後の予定など.
 - ・ 第 4 回組織委員会 (2006/10/25)
議題: ICAA 委員長 Chatt 氏との意見交換
 - ・ 第 5 回組織委員会 (2006/12/2)
議題: 今後の予定など.
 - ・ 第 6 回組織委員会 (2006/12/22) 拡大委員会
議題: 賛助・資金, 出版, 特別講演, 招待講演など.
-
- ・ 約 3000 アドレスに開催案内電子メールを送付
 - ・ 首都大南大沢キャンパス 1 号館に会場を予約
 - ・ 日本万博記念基金助成金, 花王芸術科学財団助成金を申請. 花王芸術科学財団助成金は採択されました.
 - ・ 日本化学会, 日本放射化学会, 日本地球化学会, American Nuclear Society が共催
 - ・ (株)日本旅行に業務委託(オンライン参加登録他)
 - ・ 9/19 午後にエクスカーション, 9/20 にバンケット(京王プラザホテル多摩)
 - ・ プロシーディングは Journal of Radioanalytical and Nuclear Chemistry 誌で出版
 - ・ オンライン要旨受付開始

！ 発表申し込み受付締切は 2007/4/30 です！

- ・ オンライン参加登録は 2007 年 3 月に開始予定

！ 参加登録受付早期締切は 2007/6/30 です！

組織委員会ではホテルの斡旋はいたしません, Web ページから日本旅行を通して宿泊のオンライン予約ができます.

(MTAA-12 事務局 大浦泰嗣)



第12回放射化分析の最近の動向に関する国際会議 (MTAA-12)のご案内

会議概要:

「放射化分析の最近の動向に関する国際会議」は1961年にアメリカ合衆国において第1回会議が開催され、平成19年度に12回目を迎えます。関連分野の国際会議がいくつもある中で、放射化分析に関する国際的な研究発表の場として、最も重要な会議と位置づけられています。日本での開催は今回がはじめてであり、放射化分析研究会が主体となり、その会員の中から国内組織委員会が組織され、名目的な開催主体である国際放射化分析委員会と連携しながら開催準備をすすめています。多数の皆様のご参加をお待ちいたしております。

開催日: 2007年9月16日(日)~9月21日(金)

開催場所: 首都大学東京 南大沢キャンパス

交通機関: 京王相模原線 南大沢駅

発表形式: 口頭発表(2会場)とポスター発表

課題討論:

1. 技術【機器的方法, 放射化学的方法, 研究施設, 放射化源, 検出器, ソフトウェア, 画像化, インビーム技術】
 2. 応用【考古学, 農学, 食物学, 犯罪科学, 環境科学, 宇宙地球化学, 工業, 医学, 放射性医薬品, その他】,
 3. 核データ,
 4. 分析値の信頼性(QC/QA),
 5. 分析法比較【ICP-MS, AMS, PIXE, SOR-XRF】
- これらのテーマごとの討論を通して、現在の放射化分析の動向を総括し、今後の放射化分析の展開計画について展望する。

各種締切: 発表申し込み 2007年4月30日

参加早期登録 2007年6月30日

プロシーディング原稿 2007年9月17日

参加費: 要旨集, バンケット, エクスカーション, プロシーディングを含みます。

早期登録(2007.6.30まで)

一般 50,000円, 学生 30,000円, 同伴者 20,000円

2007/7/1以降

一般 60,000円, 学生 36,000円, 同伴者 24,000円

宿泊: 組織委員会では直接斡旋いたしません。(株)日本旅行が本会議のための宿泊予約のWebページを開設いたします。

ホームページ: <http://www.mtaa12.com>

問い合わせ:

192-0397 東京都八王子市南大沢1-1

首都大学東京 理工学研究科 分子物質化学専攻 宇宙化学研究室内

MTAA-12事務局 海老原充, 大浦泰嗣

TEL:042-677-2553, 2548 FAX:042-677-2525

mtaa12@center.tmu.ac.jp

カレンダー

2007/5/19 - 20

第 68 回分析化学討論会
宇都宮大学峰キャンパス

<http://www.ab11.yamanashi.ac.jp/jsackanto/68touron/index.html>

発表申し込み締切: 2007/1/24

2007/6/20 - 22

第 16 回環境化学討論会
北九州市

2007/7/4 - 6

第 44 回アイソトープ・放射線研究発表会
日本青年館

<http://www.jrias.or.jp/index.cfm/6,7184,103,212,html>

発表申し込み締切: 2007/2/28

2007/9/16 - 21

12th International Conference on Modern Trends in Activation Analysis

首都大学東京南大沢キャンパス

<http://www.mtaa12.com>

発表申し込み締切: 2007/4/30

参加申し込み締切: 2007/6/30

2007/9/24 - 26

2007 日本放射化学会年会/第 51 回放射化学討論会
静岡市

2008/5/12 - 16

6th International Conference on Isotopes

韓国濟州島

<http://6ici.ri.or.kr/>

発表申し込み締切: 2007/12/31

参加申し込み締切: 2008/2/28

2008/6/22 - 26

35th International Symposium on Environmental Analytical Chemistry (ISEAC 35)
Gdansk, Poland

<http://www.pg.gda.pl/chem/iaeac/index.htm>

編集後記

○ 本号の発行も当初の予定よりも遅れてしまいました。申し訳ありません。幹事会で、編集委員会の設立が承認されました。次号からは、大浦、宮本ユタカ(JAEA)、川端良子(東京農工大)の3人で編集を進めていきます。発行が遅れることとなる最大の原因は原稿入稿の遅れです。いいわけのようですが、いままでは予定の原稿がすべて届くまで発行を待っていました。今後は、この点を見直して、予定どおりの発行となるように努力していきます。

△ 他の会誌の編集後記に文言は失念しましたが、届くのが楽しみになるような誌面作りを心がけて努力していきたい、との旨の記述がありました。本誌も、楽しみに待つとはいかないまでも、手に取った後、おもしろそうだなとつい読んでしまうように企画していきたいと思います。

□ MTAA-12の開催年になりました。組織委員会での準備も忙しくなっています。会員の皆様におかれましては、ぜひ研究成果をMTAA-12で発表していただき、会議を盛り上げていきましょう。

(Y.O.)

本会誌の内容および投稿募集

放射化分析研究会の情報媒体は、定期刊行機関紙「放射化分析」、および電子メールです。会誌「放射化分析」は下記の記事で構成されます。

講座・特集・解説:

専門的な記事を毎号企画していきます。記事の内容についてのご希望や提案をお寄せください。

研究紹介:

放射化分析に関する研究、放射化分析を用いた研究を紹介していきます。

研究の当事者にまとまった内容を執筆していただくものと、秀れた論文を紹介するものがあります。

特に紹介したい研究についてご意見をお寄せください。

Q&A:

会員から質問を受けて、回答やアドバイスを掲載します。どのような質問でも結構です。

回答者は幹事会が責任をもって会員の中から選定します。

施設だより:

放射化分析を行うことができる共同利用施設の近況報告。また、採択されている研究課題などを掲載します。

談話室:

会員の気軽なおしゃべりの場です。要望、話題、新刊紹介、その他、どのような内容でも結構です。

若い声:

学生や若手研究者およびこれから放射化分析を手がけようとする方々の新鮮な声を反映させる欄です。

研究会報告・最近の動向等:

最近開催された研究会の報告です。放射化分析が取り扱われている研究は広範囲な分野に顔を出している筈です。放射化分析が関係している研究課題が1件でもあれば、この欄に取り上げたいと思います。

会員の皆さんからの情報提供をお待ちしています。

博士論文・修士論文・卒業論文抄録

事務局より

会員名簿

原稿は A4 横書き、40 字 x40 行、上下マージン 25mm、左右マージン 20mm を標準として、電子ファイルにより提出してください。編集の際にレイアウトを工夫させていただくこともあります。これ以外でもご相談に応じます。

電子メーリングシステム

会員及び幹事会の電子メールアドレスが、下記のエイリアスに登録されています。
これを用いて会員相互の交流・意見交換を促進していきます。

会員: JA3@kaihoken.nuclear.jp

幹事会: JA3-kanjikai@kaihoken.nuclear.jp

JA3@kaihoken.nuclear.jp に発信すれば、(電子メールアドレスが登録されている)
会員全体に配信されます。

幹事会・事務局への連絡・要望等は JA3-jimu@kaihoken.nuclear.jp に発信して下さい。

メールアドレスを持っているけれど、事務局等からの電子メールを受け取ったことの無い会員は、アドレスが正しく登録されていない可能性があります。お心当たりの方は事務局宛ご連絡下さい。入力を修正します。

放射化分析研究会

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