1.2 PIXE

Concentration of elements in tissues of

cobalt- or cadmium-stressed barley seedlings grown hydroponically

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Abstract

The physiological effect of toxicity of Co and Cd on the barley (*Hordeum vulgare* L. cv. Minorimugi) grown hydroponically in green house or phytotron was investigated. Growth of the plants was not affected under the Co concentration between 0 and 1 µM. In the 10 µM Co treatment, however, Fe chlorosis and necrosis was observed in shoots and growth of the plant was retarded clearly. Elongation of lateral roots was severely repressed and growth of the roots was totally repressed, resulting in significant reduction of dry weight. Concentration of Co in plant tissues was elevated in 10 µM Co treatment comparing with the other treatments (0 and 1 µM Co). Concentration of Co of shoots was fairly low as compared with that of roots. Cobalt was accumulated in roots.

In Fe-deficient barley, Fe concentration of the shoots (µmol g^{-1} DW) decreased significantly in 10 µM Co treatment. But Fe concentration of roots was increased significantly. The results suggested that accumulation in roots and translocation to the shoots of Fe was repressed by Co toxicity.

The data of Co or Fe concentration of the solution obtained Flame Atomic Absorption (Flame AA) or PIXE was compared. Sensitivity of PIXE was higher and about twice than that of Flame AA. Result of statistical analysis performed on the data of Flame AA and PIXE was consistent. Iron concentration in all solution applied was a little higher in PIXE measurement than Flame AA.

Iron, Mn, Zn, Cu concentrations in xylem sap of barley grown under +Fe condition were measured by Flameless Atomic Absorption(Flameless AA) or PIXE and the data were compared each other. Fe：Except for on sample. In all of the solution, the data of Flameless AA was 1.5-2 times higher than that of PIXE. Mn: Data of Flame AA was about twice of that of PIXE. Zn: Data of Flameless was 2-5 times larger than that of PIXE. Cu: There was no consistent tendency between the data of two methods. Ratio of the data between two methods seemed to fluctuate from 0.5 – 2. Generally, PIXE gave larger values. The reason needs to be considered in the future.

There were no visual symptoms induced by Cd toxicity up to 0.5 µM Cd of the concentration of the medium. It indicated that visual symptoms of Cd toxicity may not be observed under the solutions of usual Cd-contaminated soil in nature. In dry weight of the shoots and roots, there was no significant difference among the treatment with varied concentration of Cd. Cadmium concentration of shoots and roots increased clearly at Cd 0.5 µM treatment. Cadmium concentration of roots was 15 times higher than that of shoots. The result showed that elevation of Cd concentration in this extent does not induce symptoms in plants. It was suggested that recognition of Cd toxicity in foods, such as vegetables, is difficult and that Cd can be easily incorporated into food chain and human body.

    The data of the concentration of Fe, Cu, Zn, and Mn in the solution of shoots or roots digested by nitrate was obtained using Flame AA and PIXE. The tendency of the data of Flame AA and PIXE were almost similar. In Fe, the data of Flame AA and PIXE were almost identical. In Zn, the data of Zn was a little larger than that of Flame AA. In the case of Cu in roots, the data of PIXE was 3-6 folds lower than that of Flame AA. Therefore, the data of Fe may be comparable between Flame AA and PIXE. It is suggested, however, that the values between two methods should not be compared in the data of Zn or Cu.

PIXE analysis of ecological samples collected around the Shijyushida dam

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Abstract

It was well known that the mineral polluted water containing a lot of arsenic flowed and arsenic and other toxic elements were accumulated in the deep layer at the Shijyushida dam until 1982. In order to investigate toxic effects of arsenic for the ecosystem around the dam, we have collected several kinds of ecological samples from 2005 to 2007. The collected samples were analyzed by the PIXE method. As a result, it was not found that the toxic effect of arsenic for food chain system between *Pandion haliaetus* (bird of prey as a predator) and fishes (as a pray). On the other hand, arsenic was detected from a part of subterranean stem or root of plants. It was suggested that arsenic was accumulated in the shallow layer of underground at Shijyushida dam.

Comparison of data analyzed by PIXE with XRF in chemical composition for beech forest soil samples collected in Mt. Iwaki

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Abstract

Chemical contents of soil samples were analyzed by Particle Induced X-ray Emission analysis (PIXE) and X-ray fluorescence spectrometry (XRF). A comparison of PIXE with XRF is discussed in composition for soil samples collected at Tashiro-tai plane in Mt. Hakkohda, Japan. There were differences between raw data with these two analytical methods. The content values of major elements show wider variations in PIXE than in XRF. Even though PIXE data were normalized to total oxides = 100%, the serious differences were found in alkali and alkali earth metal contents. Samples carefully prepared for another time indicate the decrease of variability. These are suggesting that the sample preparation process of PIXE might affect on the variability of data; namely, the mixing time of soil samples with Pd standard material is required more than 30 min. in agate mortar.

Heavy metal concentrations of clover and reed collected from Nanakita river mouth area, central Miyagi prefecture, Japan and their relationships to heavy metal abundances in the soil

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Abstract

Heavy metal concentrations (Zn, Cu, Fe, Mn, Mo, Pb) of clover and reed collected from Nanakita river mouth area, central Miyagi prefecture, were measured by PIXE. The heavy metal abundances and their chemical characteristics of the investigated area were previously reported. The purpose of this study is to reveal how much those plants accumulate heavy metals in their bodies and how the chemical characteristics of the heavy metals in the soil have influence on the heavy metal accumulation of the plants. We are also targeting to contribute to phytoremediation that will be dominant method to clean up contaminated soil in near future.

The heavy metals mostly accumulated in the roots of the plants and both stems and leaves have much less heavy metals than their roots. Although total abundances of heavy metals of respective plant depend on the abundances of the heavy metals in the soil, this tendency cannot be recognized in all the samples and elements. Chemical characteristics seem important. According to the previous research, each heavy metal consists of four fractions as follows: absorbed heavy metal to clay mineral (exchangeable phase), easily decomposed heavy metal by weak acid (carbonatic phase), oxidizable heavy metal by oxidizing reagent (oxidizable phase) and heavy metal phase decomposed by strong-acid (residue). The heavy metal abundances of the plant seem to be correlated with the amount of exchangeable phase. In order to precede the study of phytoremediation, the chemical characteristics of the heavy metals could be of vital importance.

Bioaccumulation of lead in young leaves of eelgrass *Zostera marina* L.

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Abstract

To evaluate the possibility of the eelgrass *Zostera marina* as a phyoremediator for a metal pollution of lead (Pb) in neritic environments, bioaccumulation by young leaves of the eelgrass was studied laboratory experiments. Eelgarass plants were incubated up to 7 days in 0.25, 0.5, 2.5 and 5 ppm-seawater concentrations of Pb. The concentrations of the metal in young leaves were 4.9 ± 2.9, 5.9 ± 2.8, 39.6 ± 20.3 and 786.6 ± 282 ppm at the respective exposed concentrations. This result shows that young leaves accumulate the metal exponentially from 2.5 to 5 ppm. The relationship between the metal accumulation (AC) at 7 days after the initial exposure and exposed concentration (EC) was described as $\log AC = 1.61 \log EC + 1.41$. The present result was compared with the previous study on the accumulation of Pb in the same eelgrass, and it was revealed that the expected AC at the EC of 10 ppm was similar to the previous study. No significant effects on the growth of eelgrass were observed in all experiments.

PIXE analysis of trace elements in cosmic dust and manganese nodule

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Abstract

Chemical compositions of spherule samples separated from deep sea sediment dredged off Hawaii island were measured by instrumental neutron activation analysis (INAA) using Kyoto University Reactor (KUR). From their chemical compositions, the origin of spherules was judged to be extraterrestrial or not. Additionally, the formation mechanism of the extraterrestrial spherules was investigated on the basis of their chemical compositions. In this work, PIXE analysis of trace elements in spherule samples was attempted to propose the criteria for judging the origin of spherules and to discuss formation mechanism of them in further detail.

Micro manganese nodule samples which were able to be obtained from deep sea sediment were preliminarily analyzed by PIXE. Based on the PIXE results and the contents of cosmogenic nuclides in those nodule samples, it is suggested that formation mechanism and growth rate of those nodule samples can be investigated.

Chemical characterization of atmospheric aerosols measured at Fukuejima and Cape Hedo in the spring of 2006

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Abstract

An intensive field program was performed to measure atmospheric aerosols at Fukuejima (32.752°N, 128.682°E) in Nagasaki prefecture, and at Cape Hedo (26.867°N, 128.249°N) in Okinawa prefecture, located in west and southwest Japan, respectively, during 13-22 March and 4-12 April 2006. A distance between the two sites was 650km. Chemical analysis of the collected aerosols with the four size ranges was made for elemental and organic carbons (EC/OC) by an thermal/optical OC/EC analyzer with improved method, water soluble ions by ion chromatography, and trace elements by PIXE. Two dust storms called as Kosa were observed in the measured period of March and April, when the mass concentration of atmospheric aerosols increased. A highly positive correlation between EC and nss-SO_4^{2-} in fine particles was shown at the both sites, and the slope of linear regression equation was almost equal to that measured at Amami-Oshima (28.444°N, 129.697°E) in the spring of 2001 and 2003. The ratio of the OC concentration in coarse particles to that in the total OC was about 0.35 and 0.38 at Fukue and Hedo, respectively, and which were much higher than that measured at Phimai (15.184°N, 102.565°E) in Thailand where the dominant aerosol was emitted from biomass burning in dry season. In coarse particles at Hedo, a positive correlation was found between OC and Cl⁻, and total Br and Cl⁻, which strongly suggests that a source of some OC might be a biogenic one produced in the surface sea. According to a satellite data analysis by JAXA, the chlorophyll-a concentration in the surface water observed north of and

around the sites was high. Moreover, CH_3Br in gas phase over the sea surface increased with the lower latitude from Hukue/Kagoshima to Naze/Naha in the spring of 2001 (E2). These phenomena could support the biogenic emission of some OC in atmospheric aerosols. A highly positive correlation between Si and Al in coarse particles was also found in the spring time at the both site. The slope of linear regression equation was, however, 2.2 and 2.6 in March and April 2006 at the both sites, respectively. This significant difference in the slope between March and April indicates that the possible source region of soil dusts was different, while the same value of slop at the both sites demonstrates that the wide region including Fukue and Hedo could be covered by soil dusts with the similar property. According to the backward trajectory analysis by the NOAA HYSPLIT model, air masses arrived at Fukue/Hedo in the strong dust storm event was transported from a different inland region of eastcoast China, between March and April. The future study on soil chemistry among the different desert area in China and Mongolia should be needed.

Innovation of the high radiosensitive mirocapsules

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Abstract

Since 2004, we reported the use of liquid-core microcapsules for anticancer drug targeting. In this study, we report the improved releasing of liquid core microcapsules via radiotherapy by Fe polymerization of alginate.

The capsules were generated by spraying a mixture of 2.0% hyaluronic acid, 2.0% alginate, supplemented with 0.2 mmol carboplatin on mixture of 0.5 mol/L $CaCl_2$ and $FeCl_2$. Resulting microcapsules were irradiated by ^{60}Co γ ray at doses ranging from 0.5 to 2.5Gy. The released carboplatin was detected and quantified by particle-induced X-ray emission. The accuracy of PIXE was tested by colorimetric assay of indocyanine green.

The generated microcapsules were 20.3 ± 3.8 μmφ in size, with a liquid core of 19.7 ± 1.2 μmφ. There were good agreements in the released liquid core between colorimetric assay using indocyanine green and carboplatin using PIXE. The releasing of liquid core of microcapsules increased dependently upon radiation dose. The released carboplatin was over 2μg with more than 2Gy irradiation, which were sufficient doses of carboplatin and radiation therapy.

Our microcapsules might lead to the new targeted chmeoradiotherapy.

Phosphorus analysis in biological materials by PIXE

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Abstract

We have investigated aluminum abundance in biological material by INAA. However, this method exhibits higher value than original aluminum value by interference reaction ($^{28}Si(n,p)^{28}Al$, $^{31}P(n,\alpha)^{28}Al$) by silicon and phosphorus in sample. Therefore, the correction for both interference elements is necessary. LSC and PIXE methods as nuclear techniques were applied to the quantitative determination of both interference elements. In comparison with the values of 14 kinds of biological reference materials, the results by LSC method agreed with the certified or reference values. In PIXE method, we applied SAPIX method and comparative method to the element determination. The comparative method was showed good agreement with the reference values, other hand, and SAPIX method showed the lower results than about 20% for almost materials. This lower quantitative phenomenon was also found in case of heavy elements and the reliability of SAPIX method was doubted.

PIXE cyclotron

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Abstract

PIXE analysis plays an important role in various fields of research such as biology, biomedical sciences, environmental sciences, archeology, and material sciences. We have performed PIXE analysis at the Sasaki Taro memorial PIXE center in Hakodate, Japan where a 3-MeV AVF cyclotron and two beam lines for horizontal and vertical irradiations have been installed. The center has not been able to offer PIXE analysis in recent years because of cyclotron troubles and the cyclotron was repaired recently.

In order to optimize acceleration variations, we measured beam profiles with internal probes and investigated in beam intensity for various parameters concerning RF system as well as internal ion source and deflector. As a result, we succeeded to transport proton beams of about 3.8 on the target, that is sufficient for the conventional PIXE analysis. We were recognized that the betatron resonance plays an important roll for the beam extraction.

A significant number of neutrons from the cyclotron due to the $^{65}Cu(p,n)^{65}Zn$ reaction were observed during the operation, indicating the main source of the beam loss in the cyclotron.

In this symposium we will report details of the present status of PIXE facilities and the above cyclotron at the Sasaki Taro memorial PIXE center.

Construction of a PIXE database for supporting PIXE studies

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Abstract

A database of PIXE data, which have been accumulated at NMCC, has been constructed. In order to fill up the database, data are newly obtained as many as possible for the kind of samples whose number is small. In addition, the data for different measuring conditions are obtained for several samples. As the number of γ-ray spectrum obtained with a HPGe detector for the purpose of analyzing light elements such as fluorine, is overwhelmingly small in comparison with that of usual PIXE spectra, γ-ray spectrum and elemental concentration of fluorine are obtained as many as possible for food, environmental and hair samples. In addition, the data taken with an in-air PIXE system have been obtained for various samples. As a result, the database involving contents over various research fields is constructed, and it is expected to be useful for researches who make use of analytical techniques. It is expected that this work will give a start to many researchers to participate in the database and to make calibration with each other in order to establish reliable analytical techniques. Moreover, the final goal of the database is to establish the control concentration values for typical samples. As the first step of establishing the control values, average elemental concentration and its standard deviations in hair samples taken from 405 healthy Japanese are obtained and tabulated according to their sex and age.

Evaluating effects of elemental composition in atmospheric particles on measured value of the developed black carbon monitor

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Abstract

It is well known that measured value of a black carbon monitor with optical technique is affected elemental composition in atmospheric particles. Consequently, in order to evaluating effects of elemental composition in atmospheric particles on the measured value of the developed black carbon monitor, we performed that 1) elemental composition of atmosphere particle sample collected with the developed black carbon monitor was analyzed by PIXE method, and 2) comparisons were made between the measured value and elemental carbon value by thermal-optical method. As a result, the measured value of the developed black carbon monitor was not affected elemental composition in atmospheric particles, and the measured value was measured in high accuracy.

The analyses of the cell lethal effect induced by low-dose radiation in glioma

－Relation of bystander effect and trace elements－

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Abstract

So far, the effects of low dose radiation have only been estimated by extrapolation from the data obtained by the higher dose radiation. Recently low dose radiation effects such as bystander effect cannot be explained by extrapolation from the date obtained by higher dose radiation. Cell death induced by bystander effect was induced by a factors secreted from irradiated cell to unirradiated cell. And it is considered that cell membrane is important target for induction of bystander effect. In this study, to elucidate bystander effect, we investigated the relationship cell membrane effect (sphingomyelinase activity) and bystander effect, and divalent metal ion that are necessary for sphingomyelinase activation using PIXE analysis.

Cell death by radiation induced bystander effect was observed in glioma cell (A172 cell). This bystander effect was inhibited by shingomyelinase inhibitor. When fluctuation of intracellular metal element was analyzed after irradiation, concentration of intracellular zinc element increased for 5 min and decreased for 15 min after irradiation. It is reported that sphingomyelonase activated for 5min after irradiation, sphingomyeliase activation and fluctuation of zinc metal was corresponding.

This result suggested that radiation induced bystander effect was caused by sphingomyeliase activation that was relative to zinc element.

Absorption of lymphatics beneath the buccal mucosa and the palatal mucosa

-Drug administration via the oral mucosa-

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Abstract

We have reported that the lymphatic architecture beneath the buccal mucosa and palatal mucosa which had the high absorption shape by morphological analysis. These lymphatic vessels absorbed the antitumor agent, and it was accumulated in the regional lymph nodes (submandibular lymph nodes), when it was injected around the tumor. The quantity of this agent became very little against the whole body and we thought that this quantity did not raise the side effects of antitumor agent in this method. We present whether it could reach to the regional and /or the metastatic lymph node or not when it is administered via the oral mucosa. Cisplatin which has the platinum in chemical structure is used in this study. The platinum was detected using the element analyze with Particle Induced X-ray Emission (PIXE) in Cyclotron Research Center (Iwate Medical University).

Ten µl of Cisplatin (0.1 mg/ml) drown in stype and sets on the left buccal mucosa and the center of the palatal mucosa of the mouse which were already reported the lymphatic architecture. After 5 minutes massage and 5 minites neglect, the right and left submandibular lymph nodes were extracted and dried at 100 degree centigrade for two days. The platinum was analyzed by PIXE.

The accumulation of the platinum in the submandibular lymph nodes from the buccal mucosa: 4.5 µg/g in the left submandibular lymph node; 4.2 µg/g in the right submandibular lymph node. The accumulation of the platinum in the submandibular lymph nodes from the palatal mucosa: 9.9 µg/g in the left submandibular lymph node; 6.5 µg/g in the right submandibular lymph node.

The oral mucosa is formed by the stratified squamous epithelium. The buccal mucosa classified in the lining mucosa and the palatal mucosa classified in the masticatory mucosa. The former has thin and the latter has thick cornified layer.

This result showed that Cisplatin was absorbed more at the buccal than at the palatal mucosa. We have thought that the palatum is very useful part for administration because the deep cervical lymph node, which is the final lymph node of head and neck region is the regional lymph node of the palatum in human. And the palatum can use for application to the drug administration using denture. We think that the buccal and the palatal mucosa are very useful for drug administration via the mucosa.

PIXE analysis of hairs at infant medical checkups
in Fukuoka city (first report)
– Comparison of mothers' hair at 1 month and 10 months after birth –

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Abstract

According to the U. S. Environmental Protection Agency, more than 80,000 chemical compounds have been released and accumulated in the air, water, and ground in various forms. Moreover, thousands of new chemical agents are released annually into the environment in our food, medicines, protective materials, and the like, and are absorbed into the human body through various routes. Only a few of these have been tested and studied extensively to determine their effects on our health. The adverse effects for human beings of environmental contamination crosses international borders and persists in subsequent generations. Harmful substances are observed at high concentrations not only in humans but also in large migratory ocean fishes and polar bears in the high Arctic. Even now, researchers have only unreliable speculation about the kinds and extent of harmful substances our bodies have accumulated.

The cause of atopic dermatitis and certain allergies that have increased continuously with high economic growth is suspected to be related to environmental contamination. However, no definite evidence has yet been obtained. Excessive intake of harmful minerals and/or deficiency of essential minerals are strongly suspected, but few convincing facts have been established. Our purpose was to determine the possible relationships between atopic dermatitis and the concentration of minerals in the hair of infants and mothers, as measured by the sophisticated method of proton-induced x-ray emission (PIXE).   We have now completed PIXE measurements at medical checkups of 842 mothers at one month and 408 mothers at 10 months. Since the PIXE measurements will be linked with clinical data after completion of all the samples, we report here some preliminary statistical results on the distribution of each element.

Sulfur (S) follows approximately the same normal distribution of the coefficient of variation 0.1 at both the one-month and ten-month medical checkups. Furthermore, the coefficient of variation of 0.025 after Box-Cox transformation is so small that the variation of S among the samples is considered to be approximately constant. Each of the remaining 28 elements follows an approximately normal distribution after the transformation. Since all of the elements are more or less normally distributed, the central limit theorem suggests that there was no systematic bias in the PIXE measurements. Since the measured values are such that "SE > measured values" are all included in the analysis, we conclude that these measurements may be also used in the statistical analyses.

Geochemical characteristics of water of Asahi River flowing through Akita Plain

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Abstract

The purpose of this study was to clarify the formation process of chemical composition of river water in Asahi River flowing through Akita Plain.　Concentrations of major elements and heavy metal components in the water of Asahi River were measured using ion chromatography and the PIXE method.　Concentrations of major elements and iron in the river water increase from the headwater to the lower reach of the river.　Zn concentration of the river water is high at the point where a tributary derived from a Cu-Ag mining area flows into, and the Zn concentration decreases below 0.03ppm at a point 14.6 km downstream.　The Na/Cl ratio of the river water is similar to the Na/Cl ratio of seawater.　The river water contains salt of seawater origin.　The K/Na, Ca/Na, Mg/Na and SO_4/Cl ratios of the river water are different from those of seawater.　　These findings suggest that the concentrations of K, Ca, Mg and SO_4 are controlled by other factors in addition to the salt of seawater origin.　Concentrations of Ca, Mg and SO_4 of non-seawater origin in the river water increase from the headwater to the lower reach of river.　The increases in these concentrations suggest that Ca, Mg and SO_4 concentrations of the river water are controlled by water-rock interaction and that the amount of groundwater that has interacted with rocks for a long time in the river water increases in the downstream direction.　Fe concentration of the river water increases in the downstream direction.　Fe in the river water is thought to be transported as suspended particles smaller than 0.45 μm in diameter.

Variation of chemical composition and style of transportation of elements in drainage water-bearing river water from an abandoned mine

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Abstract

The chemical contents of filtrate of mine drainage water-bearing river water in passage through a 0.45 μm filter and residues of the river water trapped the filter ware examined by the PIXE method to estimate the change in contents of chemical components and to know the style of transportation of the elements in drainage water from an abandoned mine.

The pH value of the mine drainage water ranges from 2.5 to 2.9, but the pH of the mine drainage water-bearing river water is 6.7 at the downstream part of the river.   Aluminum in the river water is transported downstream as suspended particles larger than 0.45 μm in diameter.   Iron changes from soluble iron and iron coexisting with suspended particles smaller than 0.45 μm to iron coexisting with suspended particles larger than 0.45 μm around pH of 4.5 according to the change from acidic pH to neutral pH.   Zinc is transported far away from the mine as soluble zinc and zinc coexisting with suspended particles smaller than 0.45 μm.

Geochemical characteristics of suspended particles in water of Shibukuro River-Tama River-Omono River system, Akita prefecture, Japan

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Abstract

The chemical composition of residues larger than 0.45 μm in water of the Shibukuro River-Tama River-Omono River system was examined by the PIXE method to estimate the ratios of amounts of elements transported as suspended particles in total amounts transported by river water in the river system. The chemical composition of the river water is controlled by formation of suspended particles and absorption of elements on the surfaces of suspended particles. Arsenic in the river water is precipitated with iron at the point at which pH of the river water changes from 3.3. to 4.2 in the upper reach of the river system. Zinc is removed from the river water as absorption on suspended particles larger than 0.45 μm at the point at which pH of the river water changes from 5.7. to 6.2 in the middle part of the river system and in a lower reach of the river system where pH of river water is around 7. The amount of zinc transported as suspended particles in river water of the lower reach is estimated to be about 10% of the total amount of zinc transported by the river water.

Determination of trace elements in organs and tissues of Zn-deficient mice by instrumental neutron activation and PIXE analyses ~Determination of trace elements in soluble proteins separated by two-dimensional electrophoresis~

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Abstract

The concentrations of trace elements in hepatic subcellulars and cytosolic protein of zinc deficient mice were determined in order to investigate the behavior and role of zinc and other trace elements.

Eight-week-old male mice of ICR strain were divided into two groups; one was fed with zinc deficient diet (<1 μg/g Zn), the other with control diet (30 μg/g Zn). After 3 weeks of treatment periods, their livers were removed. Two types of experiments were performed. In the first experiment, the liver samples homogenized with HEPES buffer which adjusted to pH 7.4 with $KHCO_3$ were centrifuged under differential conditions in order to separate into cellular fragments and 5 subcellular fractions, such as nuclear, mitochondrial, lysosomal, microsomal and cytosolic fractions. Each fraction was freeze-dried for instrumental neutron activation analysis (INAA). Concentrations of 11 elements, Na, Mg, Cl, Mn, Fe, Co, Cu, Zn, Se, Br, and Rb, were determined by INAA. In the second experiment, sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE) and two-dimensional electrophoresis (2-DE) were performed for cytosolic fraction of other mice. After electrophoresis, the gel was cut into protein bands and subjected to PIXE analysis.

Data mining analysis of serum trace elements in hospitalized patients supported by nutrition support team

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Abstract

Recently, Nutrition Support Teams (NSTs) have been spreading throughout Japan. Nutritional assessment is important as an initial step among NST activities, since the patients can be identified based on this assessment whether they needs supports by NST or not. Serum trace element is one of the most useful and convenient nutritional indices. The aim of this study is to analyze the relationships between serum trace element values and clinical backgrounds in NST patients by data mining.

The subjects of this study consisted of 29 NST patients who were admitted to our hospital between January 2005 and October 2006. Serum trace elements were analyzed by PIXE method in patients. The data were analyzed by a data mining software, i.e. "ICONS Miner" (Koden Industry Co., Ltd.). The significant "if-then rules" were extracted from the decision trees. The target variable of the decision trees is whether nutritional conditions of the patients are improved or not (Yes/No). The explanatory variables of the decision trees are the values in serum trace elements (Fe, Cu, Zn, Se, Mn) and TTR (transthyretin). The analyses demonstrated that the first node of the decision tree was Zn. Therefore, serum Zn value might be the most significant factor among these trace elements in estimating the improvement of nutritional conditions of the patients. In the decision, the second branch was the Fe value, and the Cu the third. The following significant "If-then rules" were extracted from the decision trees.

If-then rule 1:

If serum Zn value >758.6 µg/l , then improvement of nutritional condition = Y. (1.00 = 9/9)

If-then rule 2:

If serum Zn value ≤758.6 µg/l and Fe ≤653.2 µg/l and Cu ≤682.5 µg/l, then improvement of nutritional   condition =

Y. (1.00 = 5/5)

If-then rule 3:

If serum Zn value $\leqq$758.6 µg/l and Fe $\leqq$653.2 µg/l and Cu >682.5 µg/l and Se >119.8 µg/l, then improvement of nutritional condition = Y. (1.00 = 3/3)

In conclusion, data mining analysis of serum trace elements was found to be an effective method in assessing the nutritional conditions in NST patients.

Physical quantitative analysis in In-air PIXE

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Abstract

A physical method of quantitative analysis in In-Air PIXE system has been developed. Among the three parameters required for performing a physical quantitative analysis, X-ray production cross sections were calculated by considering the effective energy of the proton beam after losing its energy through a Kapton foil and air. Detection efficiencies have been obtained, according to the method we established for In-Vacuum PIXE system, where effects of absorption of X-rays in air are incorporated into the detection efficiencies. As a result, it is confirmed that the present method give us quite accurate results in the analyses of actual soil, sediment and ash samples.

Keywords : PIXE, In-Air, Quantitative analysis, Detection efficiency, X-ray production cross section

Standard-free method for hair samples in In-air PIXE

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Abstract

Standard-free method for untreated hair samples in in-air PIXE has been developed. It is confirmed that the method gives us good sensitivity and accuracy within several minutes' measurement if more than twenty hairs are attached onto the target. Even in the case where the number of hairs is less than eight, which is regular for usual in-vacuum PIXE, 10-15 minutes measurement is found to be sufficient to achieve almost satisfactory sensitivity and accuracy for elements from Cl to Pb. As the present method allows us to carry out analyses without labor in target preparation, it is expected to be quite helpful in the studies on human exposure to toxic elements. Its availability will more and more increase when the method is combined with the method of simultaneous measurement of in-vacuum and in-air PIXE we have just developed.

Keywords : PIXE, Hair, Standard-free, In-Air, Quantitative analysis, Untreated

Simultaneous measurement of two different targets by means of vacuum and In-air PIXE

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Abstract

A simultaneous measuring system of two different targets by in-vacuum and in-air PIXE has been developed in order to improve efficiency of analyses in the limited machine time. The proton beam passes through a thin target in vacuum and it allows us to perform in-vacuum PIXE, and the beam is further transported to the in-air PIXE system for analyzing another target. The beam intensity for in-air PIXE while performing in-vacuum PIXE is 1.5 nA, which is almost sufficient. The effect of slight changes in the beam transport parameters on the background X-rays for both in-vacuum and in-air PIXE has been found to be negligible. As a result, it is confirmed that accuracy and sensitivity of analysis for many kinds of sample, such as various samples in earth, environmental sciences and in bio-medicine, are almost unchanged for the both systems, and a four-detector-simultaneous measuring system has been completed. It is expected that the system will work miracle for solving the problem of deficient machine time in our laboratory.

Keywords : PIXE, In-Air, Vacuum, Simultaneous measurement, Quantitative analysis

Daily changes of elemental concentration in a human body over a long period obtained by quantitative analyses of beard and hair samples

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Abstract

Beard samples were taken from a person in the morning and at night over successive 218 days, and 543 samples were analyzed in total by means of a standard-free method developed by us and reported in the previous paper. Concentration changes with passage of time in a day were also studied. As a result, both short-term and long-term changes have been observed reflecting the changes of elemental concentration in a human body, and their correlation with the food intakes is investigated. It is found that concentrations of sodium, potassium and chlorine show the same trend both in short- and long-term changes, which indicates that they mostly exist in the chemical forms of NaCl and KCl in a human body. Difference of elemental concentration between the beard samples collected in the morning and at night is also discussed. It is found that the standard-free method for beard samples is quite useful for investigating daily changes of elemental concentration in a body.

In order to estimate daily changes of elemental concentration in a body for women and children, a new method which allows us to perform quantitative analysis of small hair samples cut into 1 mm pieces has been developed and applied to long hair samples taken from three persons. It is found that it enables us to estimate both long-and short-term changes in elemental concentration in a body in the same manner as in the case of beard analysis. These methods are expected to give us information about the pathways of human exposure to toxic elements.

Keywords : PIXE, Beard, Long Hair, Quantitative analysis, Changes in concentration, Standard-free method, Human body, Toxic element