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MEDGEO'15 6th International Conference on Medical Geology
Aveiro · Portugal

6th International Conference on Medical Geology – MEDGEO'15

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WELCOME TO

6th International Conference on Medical Geology – MEDGEO'15

On behalf of the Scientific and Organizing Committee of 6th International Conference on Medical Geology (MEDGEO'15), we would like to welcome you to this important meeting regarding ***Facing challenges and seeking solutions to promote human health*** that we feel privileged to host.

This Conference, which is sponsored by the Universidade de Aveiro, the Instituto Superior Técnico - Universidade de Lisboa, the GeoBioTec Research Centre, the CERENA Research Centre and the IMGA - International Medical Geology Association, is an opportunity to continue the fruitful scientific exchanges between geosciences and medical sciences around the world and to demonstrate the high scientific research standards that are being carried out in this reemerging discipline. The participants in the conference will have the opportunity to share their expertise in a range of scientific fields, such as geochemistry, biology, engineering, geology, hydrology, epidemiology, chemistry, medicine, nutrition and toxicology.

The MEDGEO'15 has received considerable international attention from around the world. We are happy to announce that 150 researchers from 36 countries (Algiers, Brazil, Canada, China, Czech Republic, Denmark, Ecuador, Egypt, Finland, France, Greece, Hungary, Indonesia, Iran, Ireland, Israel, Italy, Korea, Latvia, Lithuania, Mexico, The Netherlands, New Zealand, Nigeria, Portugal, Russia, Rwanda, Slovenia, South Africa, Spain, Sweden, Taiwan, United Kingdom, Ukraine, Uruguay and USA) will be joining this Conference, highlighting the importance of medical geology in research, teaching and politics.

The conference has been organized into 5 days sessions that include a wide range of topics: 1 - Environmental contaminants in health and disease; 2 - Environmental toxicology, pathology and epidemiology; 3 - Climate change and human health; 4 - Therapeutic properties of minerals and waters; 5 - Urban medical geology; 6 - Modeling, mapping and monitoring of environmental hazards and diseases; 7 - Advances in analytical methods.

The Scientific Committee compiled an interesting program of oral and poster presentations. The MEDGEO'15 Board, the committees and all the people involved in this year's symposium are pleased to present the Book of Abstracts and hope that this document will provide you with an important basis of the recent advances in medical geology. It contains the one-page of the accepted abstracts prepared by each author. The conference includes 5 relevant Plenary Lectures (Ann Pizzorusso, César Viseras, David Polya, João Paulo Teixeira, Jose Centeno), 3 Keynotes (Cássio da Silva, Jose Centeno, Pedro Cantista), 3 workshops, as well as 134 presentations, organized in 2 parallel oral sessions (68 oral communications) and 3 poster sessions (66 poster communications). To complement the conference's academic program, we have also organized a post-conference technical field trip to visit the Thermal/SPA Complex of S. Pedro do Sul.

Sincere acknowledgments to the Scientific Committee for their reviewing of the conference papers, ensuring that we all have a productive and inspiring MEDGEO'15 conference and, also to the administrative staff of Universidade de Aveiro for all their support dealing with the fees and the expenses. My personal thanks to the conference organizers for their detailed and careful preparation of the program and to Prof. Álvaro de Sousa for the creative design of the Conference.

We are also greatly indebted to the FCT – Fundação para a Ciência e Tecnologia, Caixa Geral de Depósitos, GeoBioTec Research Centre, Soquímica, Springer, Elsevier, Delta Cafés and Termas de S. Pedro do Sul for their financial support.

We are also pleased to welcome you to our city. Aveiro is deeply influenced by a lagoon called *Ria de Aveiro* which gives the city a unique distinctive character, where tradition and nature combine with a keen sense of modernity.

We sincerely wish you an enjoyable stay in Aveiro. We hope that this event will bring us all together in sharing, debating and constructing knowledge, and provide a forum for meeting new friends and developing new networks and collaborations for our future work.

And please, feel at home!

Eduardo Ferreira da Silva
(*Chairman*)

IMGA Chairperson Message

On behalf of the International Medical Geology Association, it is our great pleasure to welcome you to the 6th International Conference on Medical Geology (MEDGEO'15). It is an opportunity to continue the fruitful scientific exchanges among geosciences and medical sciences in the world and to demonstrate the high level of scientific research that is being carried out in this reemerging discipline.

We are confident that MEDGEO'15 will be a major learning experience for all of us attending. Plenary lectures, pre-conference short courses, workshops, oral and poster presentations will leave us with a better understanding of those environmental problems, risk factors and health benefits that are important to study and that we have to address in our research.

In this book of abstracts you will find very interesting works from many of our colleagues and a relevant number of students coming from various countries of different continents.

IMGA is being consolidated as an international organization bringing together geoscientists and public health scientific researchers from worldwide. Young researchers, will be our main driver for future endeavors in order to strengthen and continue the growth of our association.

The International Medical Geology Association welcome you to Aveiro, hoping that friendships formed will be re-energized across this MedGeo'15, enriching and broadening our personal and professional contacts in what promises to be a productive and remarkable scientific event.

Prof. Nelly Mañay,
(*IMGA Chairperson*)

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- **Vojtech Ettler** – Charles University in Prague, Czech Republic

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plenary

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Inhalation of environmental dust and potential impacts to human health

Jose A. Centeno, US Food and Drug Administration, Division of Biology, Chemistry and Materials Science, Center for Devices and Radiological Health, Maryland, USA; The International Medical Geology

Abstract

Atmospheric particles originate from a variety of sources, both natural and anthropogenic. While aerosol pollutants such as NO_x and SO_x are mainly from industrial activities, airborne natural mineral dust has existed as long as there has been loose particles and wind on earth. The total aerosol load in the atmosphere, as well as their metal chemistry and microbiological composition, have been shown to be strongly influenced by presiding climate systems and presence of dry land areas (deserts) and industrialized areas. Hence, natural dust is a form of geologic emission, arising from arid land areas, or from any human activity disturbing the earth's surface such as mining, agriculture, construction, etc.

Health effects from exposure to particulate matter have been widely described in the medical respiratory diseases literature. Direct contact with potentially harmful inhaled particles and the fine, fragile airways contributes to making the respiratory system a major target for dust and toxic agents. But toxic agents carried by dust can also exert adverse effects in other parts of the body as they are dissolved in the lung and absorbed into the blood stream. It is not only the inhalation pathway that needs to be considered, but also the increased exposure from dust deposition on edible crops and in drinking water sources. Thus, in order to set up preventive measures and regulations for dust levels to ensure public health, it is critical to gain knowledge about the potential health effects of environmental dust exposure. Geological information on dust sources, processes that affect mobilization, and transport of dust, as well as toxicological information on the effects and pathways of dust particles through respiratory organs are needed. In addition, careful studies on dust levels, chemical composition, and environmental pathology are required. This presentation will emphasize the global scale of the problem, in terms of its environmental, chemical, and human health implications. Examples will be presented of potential health effects of inhaled environmental dust in deployed military personnel.

Suggested reading

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3. Selinus O, Alloway B, Centeno JA, et al. (Eds) (2005). Essential of Medical Geology – Impacts of the Natural Environment on Public Health. Elsevier-Academic Press. ISBN: 0-12-636341-2.

Short CV

Jose A. Centeno, Ph.D., FRSC, is a graduate from Michigan State University and a senior research scientist at the Joint Pathology Center, USA, with over 20 years of experience in the fields of environmental toxicology and medical geology. Dr. Centeno is a co-founding member and the Past-Chairman of the International Medical Geology Association (IMGA). He is the US Officer of the IUGS-Commission on Geosciences for Environmental Management (GEM) and has served as Senior Adviser, UNESCO-IUGS-International Year of Planet Earth (2007-2009). Dr. Centeno currently hold adjunct faculty positions at several national and international academic centers and universities including Turabo University in Puerto Rico (as Distinguished Professor, Environmental and Health), Jackson State University in Jackson, Mississippi, Metropolitan University in Puerto Rico, and the Faculty of Chemistry-University of the Republic of Uruguay. Dr. Centeno is co-editor of the book *Essentials of Medical Geology – Impacts of the Natural Environment on Public Health* (2005) and *Medical Geology – A Regional Synthesis* (2010), serves on the editorial board of four scientific journal, and has organized several national and international conferences, including as the founding member of the International Medical Geology Conference series. He has been involved in numerous academic, government and professional activities including serving as a member of the Working Group for the International Agency for Research on Cancer (IARC, Vol. 74), US National Institutes of Health (NIH) grant proposal Study Sections, USAID grant proposal Review Panel, USEPA TOSCA Interagency Testing Committee, US National Research Council Committee on Earth Sciences and Public Health, and National Academies – Board on International Scientific Organizations (BISO). He is the recipient of several national and international awards, and has been invited to speak in more than 50 countries.

Use of human biomonitoring in toxicology and epidemiological studies

Joao Paulo Teixeira, Environmental Health Department, National Institute of Health, Porto, Portugal

Abstract

One of goals of Environmental Health is to prevent disease and injuries caused by chemical pollutants present in the environment. The main objective is to keep chemical exposure to an acceptable level that does not imply risk. In order to accomplish that, it is necessary to identify and quantify chemical risk through biological assessment of human exposure- Biomonitoring. Biological monitoring/ biomonitoring is currently applied in environmental and occupational toxicology as well as in epidemiological studies on the dose-response relationship between internal exposure and adverse health effects. The methods can be applied to estimate both individual and collective exposures, and can be used as tools to estimate the probability of adverse health effects either in an individual or in populations.

Human biomonitoring of dose and biochemical effect nowadays has tremendous utility providing an efficient and cost effective means of measuring human exposure to chemical substances. Human biomonitoring considers all routes of uptake and all sources which are relevant making it an ideal instrument for risk assessment and risk management. Human biomonitoring can identify new chemical exposures, trends and changes in exposure establish distribution of exposure among the general population, identify vulnerable groups and populations with higher exposures. Blood and urine are by far the most approved matrices. Biomonitoring can be done for most chemical substances which are in the focus of the worldwide discussion of environmental medicine. This especially applies for metals, PAH, phthalates, dioxins, pesticides, as well as for aromatic amines, perfluorinated chemicals, environmental tobacco smoke and volatile organic compounds. The presentation will address concepts and principles covering the utilization of biological indicators/ biomarkers in order to evaluate exposure to chemicals and risk to human health.

Short CV

João Paulo Teixeira is Researcher and the Head of Research Unit, Environmental Health Department in the National Institute of Health (Portugal) since 2005 and coordinator of Environmental and Laboratory Epidemiology (ELE) from the EPIUnit. He has a PhD in Biomedical Sciences and a Master in Public Health from the Medical School Porto University. The main area of scientific activity is concerned with the genetic damage caused by genotoxic and carcinogenic compounds, mainly in the environmental and occupational areas. His work is focused on the molecular mechanisms involved in the cascade of genotoxic/carcinogenic events in relation to exposure to xenobiotics, as well as on the factors of individual susceptibility modulating genotoxic and/or carcinogenic effects. He has published around 100 scientific papers and several book chapters on these topics.

Inorganic arsenic in rice - a review - implications for human health risk assessment and policy/regulation led mitigation

David Polya, Professor of Environmental Geochemistry and Director of Postgraduate Research in the School of Earth, Atmospheric and Environmental Sciences at the University of Manchester

Abstract

The development of our understanding of the occurrence of inorganic arsenic (iAs) in rice and its importance as a human exposure route are reviewed. Implications for human health risk assessment and mitigation, particularly through policy/regulatory instruments, are discussed. The particular susceptibility of rice to accumulate arsenic has been known for over 20 years (Nriagu & Lin, 1995) although the mechanism (Ma et al., 2008) and concerns over rice's importance as an exposure route of iAs to humans are more recent (Meharg & Rehmann, 2003; Al Rmalli et al., 2005; Mondal & Polya, 2008; EFSA, 2009; Meharg et al., 2009). The broad equivalence of iAs exposure from drinking water or rice was suggested by Duxbury et al. (2003) and is broadly justified by bioaccessibility (Laparra et al., 1995; Juhasz et al., 2006), urinary metabolite (Cascio et al., 2011) and human micronuclei data (Banerjee et al., 2013). This thus provides a basis for improved regulation for iAs in rice (cf. Meharg & Raab, 2010) and framework for assessing recent recommendations by the FAO (2014). FAO (2014) propose a draft maximum level (ML) of 0.2 mg/kg iAs in polished rice permitting the uptake of 100 µg iAs for a person consuming 500 g rice/day – this compares to 20 µg iAs for a person drinking 2 L/day of water containing iAs at the WHO provisional guide value of 10 µg/L. This disparity is a matter that requires further consideration, particularly bearing in mind that (i) such intakes from rice provide for little or no margin of safety compared to CONTAM lung cancer BMDL01 values of 0.3-8 µg.kg-bw/day (EFSA, 2009); and (ii) the role of iAs exposure through rice as a confounder to epidemiological studies of the association between health outcomes and low drinking water iAs exposures (cf. Bae et al., 2002; Lindberg et al., 2006). iAs in rice represents a health risk to many of the 3 billion people around the world who consume rice as a staple as well as some infant consumers of rice-based products (EFSA, 2014). More robust regulation is likely to encourage improve growing, marketing and consumption practices as well as the development and implementation of science-informed (cf. Zhao et al., 2013) mitigation measures reducing associated human health risks.

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Short CV

Dave Polya was educated at the Friends' School, Hobart and the University of Tasmania. He completed his PhD in 1987 at The University of Manchester on the genesis and geochemistry of the Panasqueira tungsten-tin deposit, Portugal. Polya has worked as a field hydrogeologist (at what is now Mineral Resources Tasmania), a computer programmer (Monash University), a high temperature experimentalist (as a visiting researcher, Oak Ridge National Laboratory, Tennessee) and as a geochemical consultant (including at GeoScience Limited, Falmouth, UK). Currently Professor of Environmental Geochemistry and Director of Postgraduate Research in the School of Earth, Atmospheric and Environmental Sciences at the University of Manchester, his current research interests include field, lab and theoretical studies, particularly with respect to arsenic in shallow aquifers, including in Bengal and Southeast Asia. He is an Associate Director of the Williamson Research Centre for Molecular Environmental and Head of the Manchester Analytical Geochemistry Unit.

Recent research projects coordinated included the FP6 AquaTRAIN Marie Curie Research Training Network, the FP6 EU ASIA-LINK CALIBRE Project and the UKIERI PRAMA Project. He is currently involved in further projects on the biogeochemical behaviour of arsenic in shallow reducing aquifers, assessing arsenic exposure routes and attributable health risks from both private water supplies and rice, and on a rather different tack, the removal of metaldehyde and other organic pollutants from drinking water. Prof Polya has published over 70 papers and is a member of the editorial boards for *Applied Geochemistry*, *Mineralogical Magazine*, *Water Quality Exposure and Health* and *Water*.

The earth: a natural pharmacy

Ann C. Pizzorusso, Independent Geologist

Abstract

New information regarding pre-historic man's knowledge about the healing properties of the earth and its waters is being uncovered in Italy, a land of complex geology and a long, well documented history. Through Classical Studies and archeology, we are able to examine the texts in which many ancient scientists, historians and writers tried to explain the mechanisms which made these natural pharmaceuticals efficacious. But whatever progress they made was eliminated either by time or by scientific positions which held that their ideas were folklore. Interestingly, it is now the advances in science and scientific testing instruments which are proving that which the ancients knew. This research, multi-disciplinary in nature, presents some of the solved and unsolved medical geology mysteries that have come down to us from the ancient world.

Among them are:

- radioactive waters that are good for our health, found on an island thought to have a fountain of youth
- the secret of living in areas with positive and negative magnetic fields, and how they influence our health and well being
- how amber has healing properties to reduce body pain and cure throat ailments
- sacred cave drip waters used by women to insure fertility and abundant breast milk

Additional research in these areas, using modern scientific equipment and methodology, may lead to new breakthroughs in geo-medical studies.

Short CV

Ann C. Pizzorusso is a geologist and Italian Renaissance scholar. After many years of doing virtually everything in the world of geology—drilling for oil, hunting for gems, cleaning up pollution in soil and groundwater, she turned her geologic skills toward Leonardo da Vinci. Her newly published book, Tweeting Da Vinci, explores how the geology of Italy influenced its art, architecture, religion, medicine and literature. The book was awarded 1st place for best science book of 2014.

Use of geological materials in complementary and alternative medicines

César Viseras, Andalusian Institute of Earth Sciences (IACT), CSIC-UGR, Avda. Palmeras 4, Armilla (Granada), Spain. Department of Pharmacy and Pharmaceutical Technology. University of Granada. Granada, Spain.

Abstract

Man has used clays since prehistoric times for therapeutic purposes, due to their abundance and their particular properties. Conventional western medicine continues to use clays as excipients and actives in medicinal products. Besides with this uses in biomedicine, clays and other geological materials are extensively used in complementary and alternative medicines. Clays are used in hydrotherapy to prepare semisolid suspensions that are topically administered to the patients (thermal muds). Nontronite, modified bentonite and kaolin are included in homoeopathic medicines. Clays and other geological materials are also included in health care products as well as dietary complements, traditional Chinese and Ayurvedic medicines and other complementary and alternative medicines. Although further research, clinical trials, and evaluations are needed, complementary/alternative medicine has shown great potential to meet a broad spectrum of health care needs. Safety and efficacy of these products and their components, in particular geological materials, would absolutely require a scientific orientation focused to assure high quality through following applicable requirements, being an interesting research area in the medical use of geomaterials.

Short CV

Position: Since 2001. Associate Professor. University of Granada (Spain). Since 2014. Full Professor Accreditation by the Spanish Minister of Education. Research activities in the fields of pharmaceutical uses of natural resources, preformulation and biopharmacy. H index: 21

Expertise: Control of APIs, development and controls of drug products (solid and semisolid dosage forms), powder characterization, tablet disintegrants, disintegration mechanisms, suspension stability, solid state characterization, dissolution, in vitro diffusion studies, in vivo-in vitro correlation, viscometry, dynamic rheology, characterization of hydrophilic polymers, Pharmaceutical uses of Natural Resources, Clays in cosmetics and pharmaceuticals applications, characterization of semisolids, mucoadhesion mechanisms, use of cell cultures as bioassays in formulation development, cytotoxicity tests.

Member of the Editorial Advisory Board of indexed journals, including Applied Clay Science. Associate Editor of Materials Technology: Biomaterials. Extensive peer reviewing activity in the fields of clays, pharmaceutics, biopharmacy, pharmaceutical technology, polymer science, chemical engineering, nanotechnology and biomedical nanomedicine.

MEDGEO'15

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Aveiro, Portugal

Arsenic – a beneficial therapeutic and an environmental poison

Jose A. Centeno, US Food and Drug Administration, Division of Biology, Chemistry and Materials Science, Center for Devices and Radiological Health, Maryland, USA; The International Medical Geology Association

Abstract

Arsenic is a ubiquitous element in the earth' crust with a crustal average of about 2 mg/kg but with concentrations in clastic sedimentary rocks as high as 500 mg/kg. Arsenic is transported mainly by water, although other natural and anthropogenic sources of exposure to arsenic, including volcanic emissions, forest and agricultural fires, pressure treated wood, mining and smelting activities, and burning of arsenic-rich coal, are of increasing concern. The history of arsenic is double-edged –n-dash it has a beneficial or medicinal aspect and a detrimental or poisonous aspect. In medicine, arsenicals were used in the Greek and Roman civilizations to treat a wide range of ailments. In the 1930s arsenic trioxide was the main therapeutic agent in the treatment of chronic myeloid leukemia. Later in the 20th Century, arsenic trioxide was introduced as an anticancer agent in China for the treatment of acute promyelocytic leukemia (APL). In the US, the use of arsenic trioxide in medicine has been approved by the FDA for the treatment of patients with relapsed or refractory APL. As an environmental poison, acute and chronic health effects of inorganic arsenic exposure in humans have been described from contaminated drinking water and food. An example of the breadth and severity of health problems caused by exposure to arsenic can be found countries such as India, Bangladesh and China. Of relevant to medical geology, is arsenic released by the use of mineralized-coal in Guizhou Province, P. R. China where villagers used coal with arsenic concentrations as high as 35,000 mg/kg in a residential setting. Exposure to arsenic resulted from ingestion of crops dried over coal fires, ingestion of arsenic-rich dust, and inhalation of indoor air polluted by the arsenic mobilized by coal combustion. Tens of thousands of people in the region consequently suffered from chronic arsenic poisoning. Those affected, by arsenic exposure from contaminated water or contaminated coal, exhibited typical symptoms of arsenic poisoning including hyperpigmentation, hypopigmentation, hyperkeratosis, Bowen's disease, and squamous cell carcinoma.

Short CV

Jose A. Centeno, Ph.D., FRSC, is a graduate from Michigan State University and a senior research scientist at the Joint Pathology Center, USA, with over 20 years of experience in the fields of environmental toxicology and medical geology. Dr. Centeno is a co-founding member and the Past-Chairman of the International Medical Geology Association (IMGA). He is the US Officer of the IUGS-Commission on Geosciences for Environmental Management (GEM) and has served as Senior Adviser, UNESCO-IUGS-International Year of Planet Earth (2007-2009). Dr. Centeno currently hold adjunct faculty positions at several national and international academic centers and universities including Turabo University in Puerto Rico (as Distinguished Professor, Environmental and Health), Jackson State University in Jackson, Mississippi, Metropolitan University in Puerto Rico, and the Faculty of Chemistry-University of the Republic of Uruguay. Dr. Centeno is co-editor of the book E*ssentials of Medical Geology – Impacts of the Natural Environment on Public Health* (2005) and *Medical Geology – A Regional Synthesis* (2010), serves on the editorial board of four scientific journal, and has organized several national and international conferences, including as the founding member of the International Medical Geology Conference series. He has been involved in numerous academic, government and professional activities including serving as a member of the Working Group for the International Agency for Research on Cancer (IARC, Vol. 74), US National Institutes of Health (NIH) grant proposal Study Sections, USAID grant proposal Review Panel, USEPA TOSCA Interagency Testing Committee, US National Research Council Committee on Earth Sciences and Public Health, and National Academies – Board on International Scientific Organizations (BISO). He is the recipient of several national and international awards, and has been invited to speak in more than 50 countries.

Medical Geology in Brazil: short overview

Cassio Roberto, Geological Survey of Brazil

Abstract

In 2002, after the Brazilian Geological Congress in João Pessoa (PB), a research group involving more than ten universities and institutions, created a discussion group called Environmental Geochemistry and Medical Geology Research Network – REGAGEM (regagem@ige.unicamp.br) currently with 345 members. The main objective of this group was to conceive and propose the National Research Program on Environmental Geochemistry and Medical Geology – PGAGEM, which currently is under development. The first Brazilian medical geology event, the International Workshop on Medical Geology, was held in October 2003 at UNICAMP. In September 2004, a relevant number of Brazilian researchers has participate in the Medical Geology Symposium of the 32nd International Congress of Geology (Italy). The second workshop on Medical Geology took place in June 2005 in Rio de Janeiro where the publication of the Portuguese and English versions of the book *Medical Geology in Brazil* was one of the most relevant moments of the event. Brazilian researchers have also participated in all International Conference on Medical Geology. The Brazilian Chapter on Medical Geology is created since 2008 with the main coordination of coordinators Bernardino Figueiredo and Cassio da Silva.

Currently the Natural Radioactivity Laboratory (Larana - the Federal University of Rio Grande do Norte - UFRN), under the supervision of Prof. Thomas F. C. Campos, develops two research lines in *Natural Radioactivity and Health* and *Geological Factors controlling Natural Radioactivity*. These issues were discussed in the Seminar and Workshop on Radon in Brazil organized by this team.

The *Environmental Geochemistry and Analytical Group* published in 2012 the book entitled *Chumbo, Ambiente e Saúde - o desafio do controle da exposição humana* (Figueiredo, B.R., De Capitani, E.M., Anjos, J.A.S.A. Luiz-Silva, W. (Orgs.) 2012, Editora Annablume, São Paulo, 2012, 271 p.)

Also different researchers from the CETEM-Centre for Mineral Technology (Zuleica Castilhos), the UnB -University of Brasilia (Saulo Rodrigues-Filho), the UFRJ-Federal University of Rio de Janeiro (Ricardo Cesar), UFF-Fluminense Federal University (Ana Paula Rodrigues) and Evandro Chagas Institute-PA (Iracina de Jesus) are currently developing studies on Hg contamination by artisanal gold mining areas in the in the Amazon region.

Related to training the University of Campinas (UNICAMP) under the supervision of Prof. Bernardino Figueiredo offer Postgraduate and Graduate Programmes on the thematic of Medical Geology: (a) Postgraduation: Discipline Geosciences and Environment - Areas of interest: Medical Geology and Environmental Toxicology (this discipline includes 135 hours of content Medical Geology) - In 2015 10 students; (b) Graduation - Advanced Topics Discipline of Geology from 2015. Also the Federal University of Western Pará (UFOPA) offer under the Geosciences, Environment and Health research area the Society, Nature and Development PhD (6 students in 2014).

Other research activities on Medical Geology are running in Brazil: State University of Londrina (UEL): Postgraduation on Health Geography and Medical Geology (supervision of Prof. José P. P. Pinese); Federal University of Ouro Preto-MG (UFOP): Research line on Environmental Geochemistry and Medical Geology (supervision of Prof. Adivane Costa); Federal University of Bahia (UFBA): Pb-Cd Research Group (supervision of Prof. José Angelo S. A. Anjos). Federal University Fluminense-RJ (UFF): Research Al Research Group (under supervision of Prof. Julio Wasserman), Federal University of Minas Gerais (UFMG): F Research Group (under supervision of Prof. Leila Menegasse) and also the Geological Survey of Brazil: National Program fo Environmental Geochemistry and Medical Geology under coordination of Cassio da Silva and Fernanda Cunha.

The Medical Geology is actually consolidated in Brazil, mainly in universities (in the earth sciences programmes), governments and private agencies. All conferences and symposia includes the medical geology theme in the scientific program, as well as is one of the most popular topics in the the Internet.

Short CV

Cassio Roberto da Silva, Brazilian, graduated in 1977 by UFRRJ, Master of Economic Geology in 1995 by USP, PhD in Medical Geology in 2011 by UFRJ. Works since 1998 in the Geological Survey of Brazil-SBG/CPRM. Published four books and five chapters in books on Medical Geology, Geodiversity, Geoparque and Metallogeny. Collaborates on the Medical Geology short course in Brazil. Was the chairman of three conferences (two national, one international). Received five awards (four national and one international). Working since 2003 in the Medical Geology research area is responsible for the implementation of the Environmental Geochemistry and Medical Geology Program on SBG/CPRM.

Medical Hydrology in Portugal: a brief overview

Pedro Cantista, Invited Professor of Medical Hydrology at the *Universidade do Porto – Curso de Medicina do Instituto de Ciências Biomédicas Abel Salazar – ICBAS*, President of the Portuguese Society of Medical Hydrology, President Elected of the International Society of Medical Hydrology

Abstract

Balneology tradition in Portugal doesn't differ too much from Spanish, Italian or French ones.

Being a Latin country our thermalism carries a strong roman influence. Portuguese thermal spas are located in their great majority in places where roman hot springs were exploited during the past.

Our thermal history has significant landmarks. We may underline the foundation of the first thermal hospital of the world in the Portuguese town of *Caldas da Rainha* at the very end of the XV century and the publication of one of the oldest treaties on Mineral Water Classification in the middle of the XVIII century.

(The *Aquilégio Medicinal* by Francisco da Fonseca Henriques, 1765).

The scientific evolution of Medical Hydrology in Portugal followed the same ways and methods of our neighbour countries. In our times Balneology is officially recognized in Portugal as a medical competence. It has a specialized commission within the Portuguese Medical Association. There is universitary education on this field both at undergraduate and post graduate levels. We also may find some research activity and some important papers have been published during the last years. There is a Portuguese scientific Society of Medical Hydrology founded 63 years ago (*Sociedade Portuguesa de Hidrologia Médica e Climatologia*).

The Portuguese Society is a member of the ISMH and organized and hosted with a great success the 36th World Congress of Medical Hydrology in Porto in 2008.

Although we face many difficulties in this area some research is being done lately. Some basic science experimental studies showed the biologic effects of some mineral waters using animal models. Translational science also begins to be developed and some papers were published lately.

The Thermalisme in Portugal is well organized and ruled by a specific law recently reviewed (2004).

There are around 50 balneology stations in Portugal although currently only 34 are actively operating.

Besides these, in our country more than 400 mineral water sources are registered, classified and with conditions to develop balneologic health care. Some of our thermal stations have magnificent facilities with beautiful architecture examples of spa buildings and gardens. Most of the facilities were renewed in the two last decades benefiting from modern equipment and well trained health professionals. There is a large variety of mineral water types offering the possibility of a wide scope of treatment indications. Thermal programs of the so called *classic thermalisme* usually take two or three weeks.

Short thermalism programs (*wellness*) are increasing. They keep medical supervision and are considered a health practice.

Portugal has also a *social thermalisme* although last year the Public Health System has cancelled the reimbursement of the thermal treatments.

Nevertheless all the difficulties that thermalisme faces in our days we are confident that it will remain in Portugal as an important health, social, cultural and economic phenomenon in the future. In other times we passed by similar experiences and we were able to overcome them.

Short CV

Graduation on Medical School: 1973-1979 (University of Porto- Portugal). And a Postgraduation on Medical Hydrology: 1981; Speciality: Physical and Rehabilitation Medicine (PRM) 1986 – 1990 in the Hospital de Santo António, Porto, Portugal; European Specialist (Certified by the European Board of PRM); Official Competence Titles in Pain Medicine and Medical Hydrology

Is a Consultant Senior Doctor at the Physical and Rehabilitation Medicine's Department of the *Hospital Geral de Santo António*, Porto, Clinical Director of the *Termas de S. Jorge* and *Termas de Luso* (Balneology), Consultant of PRM in Termas de Chaves and Founder of the Rehabilitation Clinic *Fisimed* and of the *Clinica de Dor do Porto.*

Actually is Invited Professor at the Porto University (Curso de Medicina do Instituto de Ciências Biomédicas Abel Salazar) teaching Therapeutics since 1989 and PRM since 1990. Is also Chairman of the discipline of Medical Hydrology and Professor on Post Graduation Medical Courses of Pain Medicine, Molecular Medicine, Sports Medicine Master, Adapted Sports Master, Medical Hydrology Master. It is also teacher in several other Faculties (in different Universities in Portugal and abroad as invited teacher), in fields such as Rehabilitation, Pain, Osteoporosis, Sports Medicine, Medical Hydrology.

Is President Elected of the International Society of Medical Hydrology (ISMH) and also President of the Portuguese Society of Medical Hydrology (SPHM); Member of the Executive Board of the ESPRM - European Society of Physical and Rehabilitation Medicine; Member of the Musculoskeletal Topic Advisory Group (TAG) that is contributing to the revision of the International Classification of Diseases (ICD) towards its 11th edition.

During his career he developed research activity mainly in the fields of Balneology, Rehabilitation and Pain. He participated in some projects of prostheses development, namely in the clinical application of pressure transducers commands devices and in the first active extension knee prototype development (back in 1991). He has been working in the ICF Development project since 2001, by invitation of Prof Gerold Stucki, integrating the initial group for the establishment of the first ICF Core sets consensus.

He published a significant number of papers in Portuguese Journals and also a few in International Index Journals. He was Editor and Director of the Portuguese Journal of PRM – *Revista Portuguesa de Medicina Física e de Reabilitação*; integrates the editorial board of *Balnea* and *Acta Fisiátrica*. More than 500 oral presentations, including keynote lectures, conferences many of them in International Congresses.

Winner of 8 scientific prizes.

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01

Environmental contaminants in health and disease

Rivers as conveyors of PAHs to a urban tropical estuary

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Abstract Type Oral Presentation

Abstract

The Guanabara Bay Basin in Rio de Janeiro houses more than 10 106 inhabitants and the second most relevant industrial district in Brazil. Because emissions of hydrocarbons from mobile and stationary sources may pose a risk to humans and to the marine life a study was performed to quantify the annual inputs through the major rivers crisscrossing the basin. For this, particulate matter was sampled monthly over one year in six major rivers and hydrocarbons were determined to assess concentration levels and, most important, source identification and quantification. For the mass balance sedimentation rates and concentration in surface sediments of the receiving body were also used. Resulting loads for PAHs were of 3.64 ± 2.4 ton/year accounting for about 30% of the inventory deposited annually in the receiving body which surpass the reported for the Susquehanna (2.37 ton/y) river, one of the five most important rivers of the Chesapeake Bay in USA (Ko e Baker, 2004), and that for the Ebro River (14 ± 2 ton/y) in the Western Mediterranean Sea (Lipiatou et al., 1997). Most hydrocarbon in sediments and carried by the rivers derive from vehicular emissions and concentrations of carcinogenic homologs surpass recommended levels.

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Heavy metal levels in mussel (*Mytella falcata*) collected in the northern Todos os Santos Bay, Bahia, Brazil

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[3]Graduate Program of Food Science and Laboratory of Toxicology, College of Pharmacy, Federal University of Bahia, Rua Barão de Jeremoabo, s/n, Campos de Ondina, CEP: 40171-970, Salvador, Bahia, Brazil.
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Abstract Type Oral presentation

Abstract

The Todos os Santos Bay, is one of the most important waterways in Brazil (1.100 km²) and the second largest Bay of the world, which is located in the vicinity of Salvador, the third largest metropolitan area in Brazil. This Bay is the home of the largest petrochemical complex in the southern hemisphere. The northern portion of the Bay lies within the area of four municipalities (São Francisco do Conde, Madre de Deus, Salvador and Candeias). Many sources of anthropogenic pollution are present such as sewage disposal and industrial waste, the latter consisting mainly of oil refinery effluents and naval industries. At this Bay, in the Reconcavo area, the capture of shellfish is strongly linked to the artisanal fishing tradition, exploring the aquatic environments near the coastline. The contamination of bivalve mollusks is primarily due to the feeding on suspension and selectively filtering small particles of phytoplankton, zooplankton, viruses, bacteria and inorganic matter from the surrounding water. As seafood consumption is a potential risk to public health, their control is extremely important. Thus, the objective of this study was to monitor the contamination by heavy metals in mussels (Mytella falcata), collected in northern Todos os Santos Bay (Bahia, Brazil), during the period of one year. The study was conducted at the Paty Island in the town of São Francisco do Conde near to an oil refinery. The collections of mussel samples were carried out bimonthly from December 2013 to November 2014. Four sampling sites were designed, two on each side of the cultivation area, totaling 24 samples. The fresh mussel specimens with shell intact were transported to the laboratory in refrigerated isothermal boxes, after scrubbing under tap water for debris removal; the shells were aseptically opened using a knife. The flesh and intervalve liquid were placed in bags and stored in the freezer until processing. Mussel samples were lyophilized and grounded in a mortar. After acid digestion, the mineralized samples were subsequently submitted to heavy metal determination (Ni, V, Cd and Pb) by electrothermal atomic absorption spectrometry (EAAS). For quality control purposes, standard reference material, oyster tissue (NIST 1566b), and reagent blank were analyzed in each batch. Mussel's heavy metal concentrations (dry weight) ranged 0.98 to 2.79 µg/g of Ni, 5.19 to 11.51 µg/g of V, 0.75 to 1.13 µg/g of Cd and 0.33 to 1.28 µg/g of Pb. For the metals present in the oil refinery effluents, used as catalyzers (Ni and V), it was observed the highest concentrations at the end of the wet season (mean and SD) 2.79±0.209 µg/g and 11.51±1.687 µg/g, respectively. Ni levels are far below the FDA recommendation as the tolerable limit (80 µg/g d/w). For V, the WHO recommends the limit for mollusks of 0.77 µg/g wet weight. The highest V concentration observed in this study (2.44 µg V/g mussel w/w) is 3 folds higher than the WHO limits.

Total hair mercury levels and association with pre-clinical renal effects in adults

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Abstract Type Oral Presentation

Abstract

Heavy metals like mercury (Hg) are considered nephrotoxic even at low levels, particularly affecting the cell lining of the proximal convoluted tubules. Among the non-occupationally exposed, seafood based diet is the main source. Todos os Santos Bay and Aratu Bay in Bahia, Brazil have been contaminated by several industrial and port activities. This study aims to assess the exposure to Hg and the association with effects on renal function in adults living in the communities of Cotegipe (CT) and Santa Luzia (SL) in Simões Filho, Bahia. This is a cross-sectional study, in which volunteers (n = 88) aged between 17 and 55 years were included. Total Hg levels were analyzed in hair (HgH) and in urine (HgU) by cold vapor atomic absorption spectrometry. Renal effect was evaluated by the estimated glomerular filtration rate (eGFR) and subclinical biomarkers of effects on tubular cells (low molecular weight proteins RBP, β2M and wall enzyme NAG). The median levels of HgH in SL and CT were 0.49 and 2.77 µg/g creatinine, respectively. Tukey post-hoc test demonstrated that the Intermediate and High tertiles of HgH levels presented significantly higher renal effect marker levels when compared to the Low tertile. Multiple regression analysis demonstrated a positive association of logHgH with logRBP (β = 0.242, 95%CI 0,102-0.383), independently of sociodemographic factors. logHgH levels also remained associated with logNAG (β = 0.373, 95%CI 0.108-0.578) and logβ2M (β = 0.277, 95%CI 0.108-0.446) after adjustments. Even though the exposure to heavy metals in such communities is at low levels, these results show that renal function may be affected at a pre-clinical level.

Indoor radon in several regions of Portugal and need to reduce radon exposure

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Abstract Type Oral Presentation

Abstract

Radon measurements were performed indoors and outdoors in several regions of Portugal in order to assess the buildup of radon concentrations indoors and to relate these concentrations to uranium series radionuclide concentrations in soils of those regions. Average radon (^{222}Rn) concentrations in indoor air at ground floor were as high 5600 Bq/m^3 in houses in the Viseu and Guarda districts in the granite-dominated regions. In the Lisbon area, a sedimentary region, radon averaged around 10 Bq/m^3. In the Alentejo, radon concentrations averaged from about 10 to about 150 Bq/m^3 depending upon the local geology of the areas. Radon concentrations inside buildings generally were much higher than outdoor concentrations, and resulted from the radon exhalation from ground and its accumulation inside buildings. Regions with frequent high indoor radon concentrations generally were the regions displaying higher uranium (^{238}U) and radium (^{226}Ra) concentrations in soils. Such regions are also the regions with higher lung cancer incidence in the country. Prolonged exposure to radon from uranium radioactive series may be a radiological hazard and radon is recognized by the World Health Organization as a carcinogenic agent, ranking second only after cigarette smoke in triggering lung cancer. Recently, the European Union established a guideline of 300 Bq/m^3 as a limit to radon concentration in indoor air, applicable to workplaces and residential buildings. The preliminary work carried out here showed that, besides high indoor radon concentrations in homes and workplaces inside buildings such as spas, radon in underground workplaces, such as metal mines and show caves, might also exceed the guideline value. A systematic approach to radon risk assessment and radon exposure management is needed at a national level to abate radon exposure and lung cancer.

Chemical controls on soil iron geoavailability and nutrient supplementation associated with geophagy

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Abstract Type Oral Presentation

Abstract

Voluntary soil ingestion in humans (geophagia) has been associated among other reasons with micronutrient supplementation, particularly Fe. For centuries, it has been postulated that geophagic soils (commonly described as Fe-bearing clay-rich soils) can supplement humans with significant amounts of dietary iron upon ingestion. In contrast however, research over the past decade suggests that high total Fe content in soils does not necessarily translate into bioavailable Fe. Unlike for the seemingly well appraised iron dynamics of soil-plant-microbes systems, biochemical and physiological interactions of Fe (hydr)oxides in humans through geophagia remains elusive. This in part, may be attributed to the complexity of the human digestive system (such as variability in pH and Fe solubility) and its bearing on Fe bioavailability and bioaccessibility. Alternately, the bioavailability of Fe in soils may be influenced by a range of (bio)chemical processes involving precursor minerals such as pyroxene, amphibole, biotite, olivine, sulphides as well as post depositional phase reactions (protonation, reduction and complexation reactions involving Fe^{2+} and Fe^{3+}). These reactions have equally been shown to control sorption or desorption of certain essential and toxic elements in plants and other natural environments. However, their application in geophagia and nutrient supplementation, to the best of our knowledge has not been documented. This work explicates (1) the effect of organic ligands on iron geoavailability (defined herein as the solubility and dissolution of Fe-oxides) in geophagic soils, and (2) Al – for – Fe substitution and its coprecipitation effects on other essential/toxic elements commonly present in geophagic soils.

A review on Medical Geology in Africa: some examples of naturally occurring geological factors

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Abstract Type Oral Presentation

Abstract

Although there is a growing development of Medical Geology in the world, it is in Africa that the application of research results would be most relevant. However, it is in Africa that the field is least developed. The African continent is characterized by a complex and dynamic geological history including frequent earthquakes, volcanic activities in tectonically active regions, pervasive dust, water toxicity due to interaction with the geological environment etc. etc. All these naturally occurring processes and materials could have short and long term impact on human and animal health. In addition, most of the population in Africa lives close to the land, relying on locally produced food and water, and large tracts of cultivated land are arid, semi-arid, or lack essential trace elements for healthy plant growth. Therefore, considering the significance of the health problems possibly related to the naturally occurring geological issues on the African continent, we strongly believe that it is necessary to develop this discipline. This would lead to broadening our understanding of the diagnostic spectrum as well as therapy for many geological related health issues and thus improve life quality on the African continent. In this presentation, we will present some examples of naturally occurring geological process and materials, which might be the cause of a number of health issues occurring in Africa such as some types of cancer, thyroid issues, fluorosis, silicosis, etc.

An investigation on heavy metals and trace elements contents in thermal waters from volcano-hosted hot springs in Sabalan geothermal area, NW Iran: Qaynarja - Nir hot spring case study

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Abstract Type Oral Presentation

Abstract

This paper deals with dissolved heavy metals with high contamination risk in Qaynarja-Nir hot spring with focus on arsenic component. Qaynarja hot spring located in the southeastern flanks of volcanic Mt. Sabalan geothermal area with geographic coordinates of 38 00 20.80 N 48 56 37.86 E in an elevation of 1704 masl. Actually, the area is tectonically semi active so that has experienced several earthquakes with low and higher intensity during the time. Subsequently, there have been temporarily extreme variations with the chemical compounds dissolved within the spring hot water. The spring has a temperature about 70°C and a flow of about 16-20 L/s. A sampling has been directed when the spring apparently was in its equilibrium state. According to the sample analyses the spring is classified among hydrothermal sodium-chloride water types. A sampling and analyze for trace elements and heavy metals investigation has also directed. The elements As, Co, Cr, Cd, Pb, Sn, Cu, Si, Zn, Ni, Mn, Fe, V, Mo, Ag, Se, B, Ba, Al, Sb has been considered as of contaminants which can highly influence the downstream environments. The hot spring discharges to the major river Baliqli Chay which has been harnessed by the reservoir dam Yamchi at downstream to supply drinking and irrigating water for thickly populated city of Ardabil and its communities. The sampling operation has been directed in two groups; hot water from the mouth of the hot spring and muds precipitated within the transferring channels ending to the river Baliqli Chay. The result of sample analyses are as follows: As = 3653.8-125752; Co = 2.3-4581; Cr = 4.4-2280; Cd = 0.03-4; Pb = 0.4-686; Sn = 51.7-43900; Cu = 6.6-43574; Si = 31.2-63152; Zn = 40.8-79840; Ni = 2.9-12549; Mn = 49.9-182172; Fe=0.3-389; V=12.6-6012; Mo=6.3-390; Ag=15.9-5589; Se=7.2-11228; B=28.8-9136; Ba=127.1-59607; Al = 231.9-2152234; Sb = 4.1911. It is noted that there are pairs of figures for every component which the first figure presents the element's concentration within the water sample and the second belongs to the concentration of the element within the mud sample. It is also noted that all of the units are in µg/L except for Si, Fe and B that are in mg/L. According to the standards issued, the most of the elements above are in anomalous content both within the water and mud. Moreover the area is thickly populated and agriculture and husbandry are the most important food supplies for the indigenous people. Both the drinking water and the irrigating water are supplied by the river Baliqli Chay and the reservoir dam. On the other hand there are various epidemic diseases reported in the area that are believed to be in connection with the polluted waters and soils. However, further investigations are currently fulfilled on this subject.

Oxidative stress parameters in relation to field production of soybean seeds in Uruguay

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Abstract Type Oral Presentation

Abstract

Soybean crop became the main summer crop in the last 10 years in Uruguay. Seed deterioration is due to inappropriate conditions regarding humidity, temperature, microorganisms, soil and water salinity and metal levels so damage can be caused both by biotic or abiotic regional factors. To ensure a good harvest, Uruguayan government regulates the procedures for the evaluation of seed quality, heeding ISTA rules. In spite of this, producers of the region found that some seeds that performed well in the in vitro tests did not produce good crops in the field, even when planted in similar soils and with the same climate as well as the same planting procedures. Oxidative stress, characterized by high levels of reactive oxygen species, can produce damage in membrane lipids, proteins and nucleic acids leading to cell death. Protective mechanisms have evolved within the seed involving several free radical and peroxide scavenging enzymes, such as peroxidase, catalase and superoxide dismutase (SOD) and also non-enzymatic compounds such as glutathione, ascorbic acid and polyphenols. With the aim to observe a possible correlation between antioxidant activity and performance of regional seeds, soybean seeds were assessed for antioxidant systems. Enzymatic systems were evaluated determining the superoxide dismutase activity using the method based on the inhibitory effect of SOD over the reduction of NBT by the O_2- generated by xanthine/xanthine oxidase system. Basal superoxide anion level was determined by spectrophotometric methods in the same extract. Non-enzymatic antioxidant activity was determined as DPPH radical scavenging capacity of an ethanolic extract following Brand-Williams method. Trace elements were determined by means of Atomic Absorption Spectrometry. Additionally, comparative proteomic profiles consistent with transgenic soybean seeds were obtained using 2-D PAGE, and no significant difference was observed when batches of different performance in field were compared. SOD level was in accordance with the reported for soybean seeds of nearby regions, ranging 20 to 80 U/mg protein. Both SOD activity and superoxide content correlated with in vitro quality tests performed on the same seeds. Superoxide content was significantly lower in seeds of good performance in field. No significant variation was detected for DPPH scavenging activity between seeds of different performance, values in accordance with those reported for yellow seeds. SOD constituents Fe, Cu, Zn, Mn and Ni levels presented ranges of: 47.0-90.6 mg/kg, 10.7-15.0 mg/kg, 33.9-51.5 mg/kg, 19.5-24.1 mg/kg, 3.9-5.8 mg/kg respectively. These results were in accordance with reported ranges, with the exception of Zn that was higher in some batches of seeds of good in vitro quality performance but poor production in field. These studies showed that superoxide radical concentration and Zn level can be useful parameters to predict performance in field of our soybeans seeds.

Medical geology approach in environmental health studies: the Uruguayan experience

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Abstract Type Oral Presentation

Abstract

Medical Geology is a developing discipline in Uruguay since 2005. There is a need of a multidisciplinary approach to environment and health issues in common topics of interest as metals bioaccessibility, speciation, remediation, bioavailability, trace elements deficiencies and overexposure adverse effects, etc. to study the interactions and impacts of natural and anthropogenic factors on health. Highly qualified teams have been integrated in Uruguay to carry out research work, teaching, training and extension activities within the University and government stakeholders from health care and environment institutions. Main study areas are environmental lead exposure, arsenic and fluoride in drinking water, selenium in food, silica and asbestos in the air, deficiencies of essential elements such as copper in animals, among others environmental health issues of concern. This work highlights the importance of the Medical Geology approach on the studies of health impacts of these metals environmental contamination, illustrated by our Uruguayan experience. Lead and Arsenic exposure risks are the major subjects of interest within our research team so we will focus on these examples. Lead pollution was first taken into account in Uruguay as an environmental health problem in early 2001. Since then, several studies in human populations (infants, children, adults, workers) and animals (dogs) were performed to show the incidence of different environmental factors on human blood lead levels, and the fact that pets exposed to lead, can present early adverse effects so they can be "sentinels" of environmental lead hazards to human health. Lead sources and remediation aspects have been mainly taken into account by geoscientists while health care issues have been carried on by biomedical scientists. As a consequence, several laws and decrees are now regulating medical and environmental intervention to prevent vulnerable populations lead exposure and also to lead wastes management and disposal. Arsenic (As) in groundwater has been recently studied in different aquifers of the country and As levels reported showed different concentrations through the whole country within a wide range. All rocks sampled contained some As, typically between 1 and 5 mg/kg. However, our state drinking water supplier is responsible for coverage over 90% of whole population and set the national maximum acceptable limit of 20 µg/L for As, with a target value of 10 ug /L (WHO guidelines). Arsenic exposure at the workplace has to be systematically assessed in Uruguay, because new occupational legal regulations have been recently established. Therefore, there has been a special need for conducting research studies on this environmental health issue in the country and to develop available analytical tools to assess As levels and its speciation in water and in urine of workers for law-abiding. The results of those studies in Uruguay and several of the ongoing research projects shows the importance of a Medical Geology approach to environmental health problems.

The daily selenium intake and health risk assessment for human from high-Se areas of Enshi (China)

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Abstract

Enshi prefecture of Hubei Province is well known for human selenium (Se) poisoning in the early 1960s in China, where sporadic cases of Se poisoning in livestock and humans are still being found at present. In this study, Se contents of crops and foods from Enshi were investigated, and the probable daily intake (PDI) of Se for local residents was estimated. Results showed that Se concentrations ranged from 0.16 to 37 mg/kg in crops and was dependent on crop species and Se bioavailability in soils. On the basis of consumption and Se content of foods, cereal consumption is determined to be the major pathway of Se intake for local residents, followed by vegetables, meat, and drinking water. It is noted that, when assessing health risks for humans in high-Se areas, the contribution of drinking water to PDI cannot be ignored due to high Se concentrations and the predominance of Se (VI) species. The PDI of Se for local residents is approximately 2140 μg/day, which was considerably higher than the upper tolerable nutrient levels (UL, 400 μg/day) referred by WHO and US EPA, suggesting that a high risk for human chronic Se poisoning may occur in high-Se areas of Enshi, China. Furthermore, the Se level in blood was predicted to be around 3250 μg/L, whether using a well-documented empirical linear relationship (3229 μg/L) or a pharmacokinetic model (3267 μg/L). The results also suggest further a potential chronic Se poisoning risk to local residents. Local inhabitants should be advised not to grow crops in high-Se lands or irrigate using high-Se water. If possible, they should not drink local spring water and consume foods mixed with those from outside the high-Se areas.

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Heavy metal and identification of helminthes in common fish (*cyprinus carpio*) obtained in a natural aquatic ecosystem in Mexico

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Abstract Type Oral Presentation

Abstract

The objective of this study was to quantify the bioaccumulation of iron, silicon, strontium and zinc in muscle and gills tissues of common fish (Cyprinus carpio). A second objective was to measure total frequency of parasitism (FP), frequency of parasitism by specie (FPE) and the dominant effect of species in fish. Eighteen fishes (n = 18) were captured to reach the first objective while 30 independent fishes (n = 30) were obtained to accomplish the second one. All fishes were obtained in the Laguna de Bustillos which is an important aquatic ecosystem in the north of Mexico. In muscle tissues (mg/kg dry weight) the concentrations ranged from 19.36 to 80.66 for iron; 36.11 to 79.58 for zinc, while levels for silicon and strontium were very low or undetectable. In gills, the levels were remarkably high if compared to muscles. The concentrations (mg/kg dry weight) ranged from 196.66 to 697.20 for iron; 19.96 to 96.25 for silicon; 121.98 to 281.37 for strontium and 859.87 to 1654.99 for zinc. It was found a FP of 90% because most of the specimens were parasitized. Gyrodactylus spp was found in gills, Pseudocapillaria tomentosa was noted in the intestine and Botriocephalus acheilognathi was parasitizing the intestinal mucosa. In addition, the results showed a FPE of Gyrodactylus sp. with 76.67%, Pseudocapillaria tomentosa with 83.33% and Botriocephalus acheilognathi with 6.67%. It can be concluded that heavy metal levels found in fish samples do not represent a risk for human consumption. With respect to parasitism it is highly recommended to local inhabitants that fish meat may be consumed after cooking temperatures exceeding 60°C for 10 min which would kill the larvae, which may be zoonotic to humans.

A Medical Geology curriculum for African Tertiary Geoscience Institutes

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Abstract Type Oral Presentation

Abstract

Medical Geology is an emerging scientific discipline which explores the connection between geological materials and processes and the geographical distribution of health problems. Knowledge about the origin, dynamics and effects of environmental contaminants associated with the geological environment would no doubt contribute immensely towards better diagnoses and therapy. Africa's unique geoenvironmental condition gives added relevance to such studies, underlining the need for geoscience and public health students in Africa to understand the principles and applications of Medical Geology in their pre-professional training. A robust curriculum for an M.Sc. programme in Medical Geology is proposed for African tertiary geoscience institutions. A field based and project oriented curriculum format is advocated, with the objective of providing a vibrant learning environment that would enhance student development. But the design is also flexible, rendering the programme adaptable to various didactic circumstances, such as the specific scientific backgrounds of candidates to be admitted into the programme, and the potential employment situation likely to be encountered upon graduation. It is recognised that to maximise the benefits of such a programme, entering students must have a background in the natural or public health sciences, and if necessary, undertake at least a solid semester of elementary geochemistry (theory and laboratory work), since this discipline (geochemistry) embodies the very foundations upon which the subject of Medical Geology is built. The modules provide extended enquiry-based investigations that employ real geochemical data sets, epidemiological records, public health statistics and visualisations, as well as performance assessments that provide evidence of Medical Geology knowledge and enquiry strategies seldom captured in traditional curriculum formats. At a time when African universities and research institutes are encouraging interdisciplinary studies, and new correlations between the geological environment and health continue to be discovered and interpreted around the continent, the introduction of graduate programmes in Medical Geology seems all too appropriate and timely.

Chronic intoxication of cadmium and fluorine in southwestern China: a geo-environmental perspective

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Abstract Type Oral Presentation

Abstract

Endemic fluorosis related to coal combustion has affected around 35 million people in southwest China. Such fluorosis can be prevented using either low-F coal or chimneys that vent the emitted F outside the house. However, a recent epidemiological study revealed that endemic fluorosis related to coal combustion in the Three Gorges region of China was not significantly alleviated by efforts to improve domestic combustion of coal; on the contrary, the number of people exhibiting symptoms similar with fluorosis (i.e., teeth and bone problems) actually increased in some areas. Our recent investigation of this endemic disease revealed surprisingly high Cd concentrations in the local environment and in the urine of the local population, suggesting that Cd intoxication might be responsible for some of the observed illness. Abnormally high Cd concentrations were observed in local soils (0.12-42 mg/kg) d ue to geogenic weathering of Cd-rich sedimentary rocks (0.22-21 mg/kg). Cadmium in soils could be easily translocated to crops as a result of high potential bioavailability of Cd. Average Cd contents (0.68 mg/kg) based on fresh weight in vegetables were exceed the safety limits of China. The rice samples purchased from local markets showed permissible Cd contents (0.01-0.13 mg/kg), as rice paddy are unavailable due to the sloppy terrain and scarcity of surface water. Water samples collected from local wells, brooks and rainfall displayed low Cd levels (0.05-0.36 μg/L). The daily Cd intake rate of local residents was estimated at 260 μg, four times the reference dose (60 μg), and the ingestion of Cd-rich vegetables accounts for 90.5% of total Cd intake. As a biomarker of cumulative Cd exposure, urinary Cd of local residents ranged from 0.43 to 27.6 μg/L (mean at 4.3 μg/L). No significant differences were found between the male and female. Age seemed to lead to an increase of urinary Cd, the group over 20 yr showed higher urinary Cd (5.72 μg/L) than that of the group under 18 years (1.64 μg/L). The fluorine in urines of the study area in 2006 (mean at 2.14 mg/L) were significantly lower than that in 1986 (7.0-13.8 mg/L), benefitted from the effective prevention of government. However, the health risk resulted from Cd exposure were overlooked. Toxicological studies demonstrated that patients who suffered from either F or Cd intoxication exhibited similar clinical symptoms in teeth and bones. Their permanent teeth tended to be mottled with minute white flecks, and with yellow or brown spots scattered irregularly over the tooth surface, their gaits displayed bilateral lameness and stiffness, although these symptoms occurred to different extents due to the wide range of exposures and nutritional conditions in the study population. Therefore, we hypothesized that Cd was a serious hidden toxin whose effects were concealed by those of fluorine, and the endemic disease of this area may be a Cd-F endemic disease rather than the single endemic fluorosis.

A systematic review of fluoride concentration factors in ground waters of Fars Province, Iran

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Abstract Type Oral Presentation

Abstract

The study area is located in south part of Iran (Fars province), the aim of present study was to systematically review fluoride concentration in southern Fars province and introduce the main factors of fluoride concentration in groundwater. The wide range of fluoride in water result of water-rock interaction that could be the main factor for fluoride concentration as natural source. The data obtain from analysis indicate that the variation of fluoride was 0.1 to 3.6 mg/L an average of 0.67 mg/L for southern part of Fars province such as Ghir and Karzin (max. 1.84 mg/L), Larestan (max. 1.88 mg/L), Parsian (max. 3.6 mg/L) and Firozabad (max. 2.3 mg/L).There was no correlation between pH and fluoride content of water samples. Seventy percent of water samples contain fluoride less than recommended level WHO, but fluoride content of thirty percent equaled or exceeded the recommended level. The most contaminated sites located near Persian Gulf or dry lakes. Reports also show dental fluorosis prevalence up to 67% in some regions of Fars such as Larestan region. So latest study in these parts of province suggest that fluoride concentration raise dramatically in last 20 years result of water table changing by anthropogenic sources. Fars province in middle south of Iran experiencing water table dropping very quickly, as people drain aquifers for agriculture use for these decays, So aquifer depletion process one the most important factor of increasing fluoride concentration in ground water beside water-rock interaction previously known as the only factor.

Effect of crater water flows of Ijen vulcano to public health at Situbondo District in East Java Indonesia

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Abstract Type Oral Presentation

Abstract

Activity Ijen volcano in East Java, Indonesia, in addition to producing toxic gases, volcanic ash, sulfur sublimation, also have producted water crater acidic (low-pH), and it contains elements of fluoride (F). This crater water flows into the river in an area downstream of Situbondo, will have a negative impact on health that cause teeth to yellow and porous, (dental), also on human skin will become itchy and scaly, (dermatitis) and stomach diseases (diarhe).

Results of research conducted by Geology Agency, Ministry of Energy and Mineral Resources shows that the degree of acidity (pH) of water crater from 0.3 to 0.8; Banyupahit river (upstream) and Banyuputih river (downstream) from 2.4 to 3.8; wells water of residents from 6.5 to 7.4. Fluoride element (F) on the river from 1.65 to 2.13 mg/L and the wells water from 0.15 to 1.42 mg/L; content of Sulfate (SO_4) from 32.79 to 34.7 mg/L and chloride content (Cl) 2.47 to 12.45 mg/L. Low acidity and high fluoride element is very dangerous for health, especially dentis, dermatitis, and diarhe.

Environmental exposure of naturally occurring thallium and health risk

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Abstract Type Oral Presentation

Abstract

Little is known in literature about thallium (Tl) exposure from naturally occurring contamination. This paper draws attention to the potential health risk posed by high concentrations of naturally occurring Tl in the environment. The inhabitants of a rural area of southwest Guizhou Province, China, live within a natural Tl accumulated environment, resulting from the Tl-rich sulphide mineralization, facing a severe Tl exposure in their daily lives. High Tl concentrations were detected in urines of the local residents. Measured urinary Tl levels are as high as 2.51-2.668 μg/L, surpassing the accepted world urine Tl level <1 μg/L for "non-exposed" humans. The urinary Tl levels show significant difference among 3 communities (n = 21, p = 0.001), but no significant difference in either sex or age groups (n = 21, p = 0.7806). However, there is a positive relationship between the extent of Tl exposure in soil and crops in the immediate environment and the levels of Tl detected in urine. The urinary Tl concentrations correlate with the extent of exposure, in terms of geographical, dietary and behavioural differences. The already affected health of the local population and its correlation with the Tl contamination in the surrounding environment warrants detailed epidemiological studies. This study has been able to identify that the elevated urinary Tl levels are mainly attributable to Tl accumulation in locally grown vegetables acquiring Tl from natural soils. It has also been possible to identify that the Tl in the urine of the local population represent a steady-state condition with long-term exposure, and the urinary excretion values can be taken as a biomarker of total dose based upon total daily dietary intake. This study indicates clearly that natural sources responsible for the high Tl concentrations poses a potential health risk to the population, and that monitoring the urinary Tl level is a reliable and accurate way of bio-marking Tl exposure. The high concentrations of Tl in urine sound an alarm, calling for an in-depth study of the geo-environmental factors promoting the dispersion and contamination by Tl, before the health risk attains epidemic proportions.

Dental fluorosis in the island of Porto Santo, archipelago of Madeira

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Abstract Type Oral Presentation

Abstract

Dental fluorosis and skeletal fluorosis are endemic in the island of Porto Santo, in the archipelago of Madeira, both diseases being essentially due to the excessive concentration of fluoride into the water from springs consumed by the inhabitants. The researchers Silva (2003) and Silva et al. (2008a, 2008b) have determined the fluoride contents existing either in water from springs used for drinking and cooking or in water from wells used for irrigation. Fluoride contents determined into the waters collected in 33 sampling are rather higher than the maximum value (1,5ppm) recommended by World Health Organization (WHO). Anomalous contents of fluoride are also found in the soils of extensive areas of Porto Santo Island, particularly in the residual soils developed on hyaloclastite tuff dated of upper Miocene that by alteration first in submarine environment and later in subaerial environment produced interesting deposits of bentonite. The clay mineral dioctahedral smectite and the phosphate fluorapatite, $Ca_5(PO_4)_3F$ are, respectively, the main constituent and the accessory constituent of bentonite (Gomes & Silva, 2006). The effects of dental fluorosis in the inhabitants of Porto Santo Island who drink water from springs is revealed by the frequent colored stains and damage observed in their teeth. The results of the research carried out both in the field and in the laboratory will be disclosed and documented.

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My best friend, my surrogate: neurotoxic metals in pet dogs

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Abstract Type Oral Presentation

Abstract

Globally, the number of older persons is expected to more than double, from 841 million people in 2013 to more than 2 billion in 2050. These projections highlight the need for new policies aiming to ensure the creation of environments that enable older people to live healthier lives. Despite controversy, an increasing body of literature growingly highlights a significant number of positive indicators to older persons' health brought about by contact with animals (particularly dogs), with these pets being "prescribed" as a therapeutic measure. By sharing their owners' environments, and consequently exposures occurring therein, companion animals become agents of high diagnostic value. The purpose of this work is to expand the concept of "One Health" (also referred to as 'one medicine': the unification of medicine and veterinary with the purpose of maintaining clinical care, surveillance and control of cross-species disease) to include the monitoring of metals with neurotoxic potential in the old person environment using the pet as a surrogate. We started by validating hair as a sensitive biomarker for these elements, by establishing correlations with blood, which directly reflects metal exposure. Being an easy to obtain, non-invasive, integrative register able to reflect past or chronic exposure, fur presents itself as an ideal matrix. For this effect we obtained convenience samples of blood and hair from twenty dogs and using Inductively Coupled Plasma Optic Emission Spectrometry (ICP-OES) quantified its contents in Al, As, Ca, Cd, Co, Cr, Cu, Fe, Mn, Pb and Zn. Upon comparison with reference levels, blood registered elevated Fe and Zn, whereas hair showed excess Mn. All other metals concentrations where similar to those described in the literature. Statistics showed that hair was not a good surrogate for blood levels of Fe, Ca and Zn, since there were significant differences (p>0.5) between the two matrices. Since one of the main differentiating factors between pet and owner can be the type of food ingested, we decided to investigate the potential contribution of wet and dry commercial dog food to blood and hair burdens in terms of the metals of interest. For both types of food copper, iron, manganese were above daily nutrition needs, whereas for dry food this was only verified for zinc. Pets' suitability as surrogates of elderly exposure is discussed under the light of the present findings.

All you can't eat: a dust banquet of organotins

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Abstract Type Oral Presentation

Abstract

According to the World Health Organization (WHO) obesity is one of the most important public health challenges of the 21st century. There are no doubts that excessive intake of calories, lack of exercise and genetic susceptibility are important factors. However, because genes in the population do not change fast enough to explain the obesity epidemic, other causes must be involved. The environmental Obesogen Hypothesis postulates that obesity is associated with the exposure to environmental contaminants. This hypothesis was initially developed for tributyltin (TBT), after evidences in experimental animals emerged showing that this organotin compound is able to promote adipogenesis. Since then, many in vitro, in vivo and epidemiological studies were performed with other chemicals that have also been implicated in the obesity epidemic. Despite the fact that TBT is considered the model obesogen, limited information on levels to which we are exposed on a daily basis is available. In order to bridge this gap, we analyzed the levels of TBT and other organotin compounds in duplicate diet and house dust samples.

The levels of TBT and its derivatives, dibutyltin (DBT) and monobutyltin (MBT), alongside the levels of phenyltin and octyltin compounds were quantified by gas chromatography-mass spectrometry (GC-MS) using an isotope dilution method in nineteen duplicate diet samples and twenty-seven house dust samples collected in Aveiro and Coimbra districts (Portugal) between 2010 and 2012.

Organotin compounds were detected in 47% of the diet samples analyzed, at relatively low levels. Tributyltin was detected only in one diet sample (0.55 ng Sn/g dw); dibutyltin in two samples (1.1 and 1.5 ng Sn/g dw) and monobutyltin in four samples with levels between 0.47 and 1.8 ng Sn/g dw. A similar trend with higher detection frequencies for the mono substituted compounds was observed for octyltins in diet samples. Phenyltins were always below the detection limit. As for dust samples an opposite scenario occurred with moderate to high levels of organotins being detected. TBT was detected in 81.5% of the samples with values ranging from 1.4 to 870 ng Sn/g dw. Both MBT and DBT were detected in all the dust samples with values ranging from 170 to 3000 and from 26 to 850 ng Sn/g dw, respectively. Octyltin compounds were also detected in all the dust samples analyzed, with values ranging between 120 and 2300 ng Sn/g dw for MOT and between 38 and 1100 ng Sn/g dw for DOT. Our results demonstrate that diet is no longer the major source of organotin compounds and that dust represents an important source of this contaminant, reinforcing the fact that organotins are widespread in the indoor environment being, thus, humans continuously exposed.

Evaluation of antibiotic pollution in the Bolivian Altiplano and the related impacts and microbial resistance levels in soil and water

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Abstract Type Oral Presentation

Abstract

The fate and impact of antibiotic contaminants in soils depend on several processes: sorption, mobility, speciation, biochemical transformations... All these processes control the bioavailability of antibiotics to soil microbial communities and drive thus their direct (toxic) and indirect (increased resistance) impacts. Better understanding the relations between these processes, environmental factors and microbial resistance mechanisms has become a necessity. In this study, we evaluated the overall antibiotic contamination of a sub-catchment of the Titicaca Lake and tried to correlate the measured concentrations with the presence of resistance genes and/or other contaminants, in the light of the specific physicochemical characteristics prevailing in this region (high altitude, important UV radiation, variable rainfall within seasons...). The Katari watershed is located in the western part of Bolivia. It has its outlet in the Cohana Bay located in the small Lake Titicaca. The ecological balance of the lake is disturbed by wastewater discharges from rapidly growing urban areas and agricultural practices. The largest city in the watershed is El Alto, which has an insufficient system of wastewater collection and treatment. In this study, surface waters and soils were sampled at ten sites of the watershed according to the altitude gradient, the two main soil types of the sub-catchment (Regosol and Cambisol), and the main human activities and/or soil usages. Significant concentrations of sulfonamides and especially of the antibiotic Sulfamethoxazole (SMX) were detected in river waters and also in soils irrigated with wastewaters close to El Alto City. Five sulfonamide antibiotics (especially Sulfamethoxazole) were detected in soils and water, as well as Trimethoprim and Chloramphenicol. Highest concentrations were observed in zones irrigated with treated and untreated urban wastewater. In addition to field observations, batch and column experiments were performed to evaluate the sorption and mobility of SMX, the major antibiotic contaminant, in the ten soils. Impacts on soil bacterial populations (DGGE fingerprints and high throughput sequencing) and presence of SMX resistance genes (*sulI*, *sulII*, and *sulIII*) were assessed. Sulfamethoxazole resistance genes were detected only in areas were high antibiotic concentrations have been detected. The biodegradation of sulfamethoxazole was found to be important (half-lives shorter than 2 months) and controlled by the soil physicochemical properties. Cartography of SMX polluted zones within the Katari watershed was established and confronted to the SMX impact results and the specific distribution of SMX resistance genes. The batch results were used to better understand the distributions and impacts of SMX. This work constitutes the first study on the Katary watershed contamination by emerging pollutants. The results evidenced a general contamination of the basin with sulfonamides which are very mobile and quite persistent antibiotics. These results will help better predicting the fate and impact of such contaminants at the watershed scale. This study will also permit to limiting the uncontrolled release of such molecules to the environment.

Health impacts of the Green Revolution: a retrospective look

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Abstract Type Oral Presentation

Abstract

The Green Revolution of the 1960s that helped alleviate world hunger during the following five decades has also left a horrible legacy of serious health and adverse environmental impacts in many developing countries. India was in the forefront of such countries to fully embrace the Green Revolution that greatly benefitted its agricultural output, providing food security; but the heavy reliance on use of chemical fertilizers and pesticides has resulted in high incidence of cancer, hyperthyroidism, blue-baby syndrome, and birth defects in a sizable segment of the population, notably in the agricultural state of Punjab. Recorded cases of deformed babies, low birth weight, low cognitive abilities of school children are some of the additional health impacts that have affected two generations. The presentation draws attention to the horrible plight of innocent people, children included, who have been suffering because of hastily implemented policies by national governments in India and other developing countries, who were encouraged to adopt the Green Revolution by the chemical manufacturing corporations in the developed countries. While these countries themselves took steps to ban DDT from agricultural use, they were setting up factories in India and other countries to mass produce toxic agricultural chemicals that have been affecting people's health, and contaminating the land and water supplies. A brief historical review of the Green Revolution, the toxicology of pesticides and other harmful farm chemicals and its impact on human and ecological health, using examples from India, are discussed in the presentation, along with a need for global assessment of the extent of damage and call for mobilizing international resources to minimize adverse impacts. The key question - whether this food security has been worth the toll it has taken in terms of human health and a degraded environment - begs deep reflection by one and all.

The declined prevalence rate of electromagnetic hypersensitivity in Taiwan relevant to the media reports

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Abstract Type Oral Presentation

Abstract

Electromagnetic fields (EMFs) are ubiquitous in the environment. Electromagnetic hypersensitivity is depicted as people who suspected suffered from the exposure of EMFs and complained their uncomfortable symptoms. These symptoms were hardly attributed to the exposure of EMF because of the alternative etiological factors. WHO defined this as 'Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMFs)' in 2005. In Taiwan, a population based investigation of self-reported EHS prevalence found to be 13.5% in 2007; in 2012, we got the self-reported EHS prevalence as 4.8% by the same investigation method. The declined prevalence is an interesting phenomenon with the ubiquitous using of more mobile devices and stronger power density of 4G communication signals. There were studies indicated that poor reporting of the media had the potential to encourage more people to misattribute their symptoms to EMFs.

The study aimed at exploring the frequency of conflicts on mobile phone base station building reported by newspapers since 2005 to 2012, and the relevant news of EMFs.

We finished an EHS prevalence investigation and searched a database recruiting 15 Taiwan newspaper articles with the keyword contained EHS related terms in titles or abstracts. For the main purpose, we searched the conflict frequencies of base station building events during 2005 to 2012. Yearly distribution of mobile phone base stations and mobile phone communication frequencies were also analyzed.

We searched 2446 EMFs related news and 211 base station conflict news included to the study. Of the 211 news reported mobile phone base station building fights, percentage varied from 27.9% in 2005 to 6.16% in 2012. The reported peak was in 2006 (31.75%). Before the first EHS investigation in 2007, the reporting percentage was 76.78%. Since 2008 to 2012, the reporting percentage declined to 23.22%.

The declined self-reported EHS prevalence rate in Taiwan since 2005 (13.5%) to 2012 (4.8%) is a large discrepancy. Similar EHS prevalence variation in other countries was also reported, but not like the large difference in Taiwan. Little study conducted to investigate the declination of the prevalence. We found the reporting frequencies of conflict events on building mobile phone station declined from 2007 to 2012, which matched with the variation of the prevalence. Our finding indicated that the possible potential effect of media reports compatible with the research in British. In the future studies, the investigation of mobile phone base station distribution and their power density will provide the powerful explanation of our finding.

Distribution of macro, micronutrients and potential harmful elements in soils from Brazil Southeast region: Implications for the environmental health

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Abstract Type Oral Presentation

Abstract

This study was conducted in southeastern Brazil, in an area with 924.619 km², comprising the states of São Paulo (SP), Minas Gerais (MG), Rio de Janeiro (RJ) and Espirito Santo (ES). A total of 1,540 soil samples were collected using an approximately 25x25 km sampling grid. After drying, the soils were sprayed at 150 mesh and 53 elements were determined by ICP-MS, including: the macronutrients Ca, Na, P, Mg and S; the micronutrients such as Co, Cr, Cu, K, Mn, Mo, Ni, Se, Sn and Zn; and the potential toxic elements Al, As, Ba, Cd, Hg, La, Li, Pb, Sb, Ti, U and W. The results show that the following concentration for the nutrients analysed: Ca (median = 0.017%, max = 0.25%); Mg (median = 0.02%, max = 0.22%); Na (median = 0.005%, max = 0.14%); P (median = 170 mg/kg, max = 649 mg/kg); K (median = 0.03%, max = 0.16%); S (median = 0.005%, max = 0.08%); Co (median = 2.4 mg/kg, max = 25 mg/kg); Mn (median = 161 mg/kg, max = 705 mg/kg); Cu (median = 12.4 mg/kg, max = 60 mg/kg); Cr (median = 32 mg/kg, max = 130 mg/kg); Mo (median = 0.64 mg/kg, max = 2.25 mg/kg); Ni (median = 6.7 mg/kg, max = 30 mg/kg); Se (median = 0.62 mg/kg, max = 1 mg/kg); Sn (median = 1.9 mg/kg, max = 6 mg/kg); and Zn (median = 11 mg/kg, max = 53 mg/kg). In the studied area low levels of Ca, Mg, S, P, K, and Co were found in the NW regions, namely in the NW-E-SE of São Paulo, NW-W-S and center of Minas Gerais and N of Espirito Santo states. Otherwise, low amounts of micronutrients Cr, Cu, Ni and Zn were determined in E regions, as NW and NE of São Paulo and Minas Gerais, and N of Rio de Janeiro and Espirito Santo states; the Mo and Sn showed low concentrations in the NW-E of São Paulo, NW-W, center W and SE of Minas Gerais states; whereas low Mn amounts were found in the N-center E and NE of Minas Gerais and N of the Espirito Santo states. It is estimated that about 277,000 km² (30%) of the Brazil southeast region have soil deficiencies in the nutrients listed above. The concentrations of potential harmful elements to health determined in soils were: Al (median = 2.33%, max = 8.72%); As (median = 2 mg/kg, max = 15 mg/kg); Ba (median = 22 mg/kg, max = 150 mg/kg); Cd (median = 0.005 mg/kg, max = 0.10 mg/kg); Pb (median = 11 mg/kg, max = 72 mg/kg); Li (median = 2 mg/kg, max = 11 mg/kg); Hg (median = 0.02 mg/kg, max = 0.50 mg/kg); La (median = 13.2 mg/kg, max = 52.5 mg/kg); Sb (median = 0.18 mg/kg, max = 2 mg/kg); Ti (median = 0.05 mg/kg, max = 0.24 mg/kg); U (median = 0.88 mg/kg, max = 3.01 mg/kg); and W (median = 0.05 mg/kg, max = 0.4 mg/kg). High Al amounts were found in NE regions of São Paulo and W-SW-S-SE of Minas Gerais states, while high As levels were determined in São Paulo and W-SE and central region of Minas Gerais states. Barium, Pb, Li, Hg, La, Ti, U and W showed high values in the coastal regions of São Paulo, Rio de Janeiro and Espirito Santo, and SE-E-NE of Minas Gerais states. It is estimated that about 185,000 km² (20%) of southeastern region showed concentrations of potential harmful elements in soils described above of concern for human health. These results are being sent to federal and state agencies responsible for the sectors of agriculture, health and environment, aiming to improve food quality and safety, as well the environmental health patterns of people living in southeastern Brazil.

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01

Environmental contaminants in health and disease

Groundwater contamination in an industrial area: the case study of Estarreja (Portugal)

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Abstract Type Poster

Abstract

The region of Estarreja in Portugal is under the influence of a large industrial complex, the Estarreja Chemical Complex (ECC), composed essentially by chemical plants that produce, among others, aniline, nitrobenzene, PVC, isocyanide polymers of aromatic base and polystyrene polymers for thermal isolation. In spite of its major contribution for the social and economic development of the region, the ECC represents a major threat to the environment and to public health. Due to the geological features (unconsolidated detritic sedimentary rocks) of this region that allows the contaminant's dispersion, there is a high vulnerability of the aquifer to environmental hazards. For decades, the different ECC industries disposed off solid wastes directly on the permeable sands without containment, and untreated liquid effluents were discharged directly on streams connected to the coastal lagoon. Although waste management practices improved significantly in the last years, there are still signs of groundwater contamination. This study aims at assessing the impact of the chemical industry in the groundwater quality and to understand the extension and the magnitude of the contamination plume in the groundwater system. Moreover, the potential risks to the human health due to the use of groundwater were also evaluated. Two sampling campaigns were performed by collecting water samples from wells and boreholes nearby the EEC. Some general parameters (e.g. pH, conductivity) and the concentration of 63 volatile organic compounds (VOCs) were determined by SPME-GC/MS, and in the second campaign a more extensive characterization of samples was performed by determining also the levels of 21 potentially toxic elements (PTEs). Results allowed to identify some "hot spots" of groundwater contamination. From the 63 VOCs analysed, 25 organic compounds were detected at least in one sample from the first sampling campaign and 15 compounds were detected in the second campaign. The highest levels were observed for benzene and dichloroethane, which are carcinogenic compounds. Hotspots of As, Cu, and Zn were also identified, but the relationship between organic and inorganic contaminants was not clear.

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Manganese in groundwater - a potential health risk in Finland?

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Abstract Type Poster

Abstract

Manganese (Mn) is an essential element required for several enzymatic functions in human body. The deficiency of Mn in humans is rare. High levels in drinking water can be neurotoxic. The human brain is vulnerable to an excess of Mn. Recent studies suggest that children are more susceptible to the neurotoxic effects of excessive exposure. Among children, Mn is associated with behavioral and intellectual disorders. Mn is a naturally occurring element found ubiquitously in water, soil and air. Increased mining activities and the use of water from drilled wells in bedrock have brought about the question of the health risks of Mn in Finland. Until these days, Mn in household water was considered only as a technical- aesthetic issue at the regulatory level. Increasing evidence, however, has shown that Mn derived from drinking water could be a health risk. For some reason, the health risk has only been associated with Mn in drinking water, not with the concomitant intake in food. Recent epidemiological studies suggest that risks to neurotoxic effects in children start to increase when the concentration in drinking water exceeds 100 ug/L. The groundwater database of the Geological Survey of Finland (GTK) consists of synoptic and monitoring samples (n = 5816) collected in 1991-2013. In about 24% of synoptic samples from drilled wells (n = 2357), Mn concentration exceeds the Finnish national regulation of 100 ug/L, which is based on aesthetic quality. About 5% of the samples exceed the former regulations of WHO (400 ug/L). For dug wells in Quaternary deposits (n = 2129) the proportions are 9% and 3%, respectively. High Mn concentrations in drilled bedrock wells are evenly distributed around Finland. The range of Mn concentrations in all monitoring samples of drilled bedrock wells was <2 to 522 ug/L (n = 412). In dug wells, the range was <2 to 2640 ug/L (n = 918). Among the dug wells, the highest concentrations were found in the Baltic Sea coastal areas where the soil type is mainly postglacial clay. In drilled bedrock well waters, Mn has significant positive correlation with many water quality main parameters, e.g. iron concentration but significant negative correlation with the parameters characterizing the hydrogeochemical conditions in the aquifer. The average level of Mn in bedrock well waters is higher than that in dug wells in Quaternary deposits. Mn concentration exceeds the level considered safe in a large portion of drilled wells. For a more detailed evaluation of the health risk, the spatial and temporal variation of Mn concentrations in groundwater needs to be known. Is one measurement of Mn concentration in water enough for exposure assessment? Do seasonal variations or the geological setting matter? It is important to know the contribution of hydrogeochemical conditions in groundwater to Mn levels in the Finnish environment. Elucidation of these points would further refine the risk assessment and magnitude of the problem.

Differences between indicators of exposure to toluene in the workplace. Developing an analytical methodology for the determination of o-cresol in urine by HPLC

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Abstract Type Poster

Abstract

Toluene is one of the most used solvents abuse (nasally). Is used in the manufacture of products such as benzene and detergents, adhesives, explosives, adhesives, glues, lacquers, etc.

Acute or chronic worker exposure to organic solvents in the workplace is given by its many applications. It has become a serious public health problem, since it is one of the causes of occupational diseases affecting various organs and systems of the human body, such as skin, liver, central nervous system and lungs. Causes dermatitis, organic brain syndrome, leukemia, cancer, and in extreme cases death.

The metabolites (hippuric acid and o-cresol) are indicators of exposure to toluene internationally recommended. Individual variation of both metabolites is high, and when they are implemented as biological indicators of exposure should be considered sex, weight, age and alcohol and tobacco. However, over time it has been demonstrated that o-Cresol is more specific exposure of toluene. Shows less interference in the interpretation of the results, however from the analytical point of view is a bit more complex the determination in urine.

Our department have developed an HPLC - UV analytical method, for the determination of o-Cresol in urine as a biological indicator of exposure to toluene. It consists in an acid hydrolysis sand with a bath at 100°C for 1 hour to release the o-Cresol presented as glucuronide or sulphate conjugate in urine; in a liquid-liquid extraction to separate the analyte from the matrix; and injection of the extract obtained in a team of High Pressure Liquid Chromatography with UV Detector for identification and quantification. The results obtained in the validation of this methodology are: linearity (r_2 = 0.998), accuracy (99.4%), precision (11.9%), LD (0.04 mg/L), LC (0.13 mg/L). From the results, it can be concluded that the analytical methodology developed is suitable for controlling the exposure of these workers, since it can detect and quantify values below the recommended.

A study of 29 workers exposed to toluene was performed and analyzed in the urine of each, the hippuric acid and ortho-cresol plus creatinine. The variability of the results for the suggested metabolites demonstrated, considering those recommended by the ACGIH (2014) values 52% of workers have values of o-cresol above the accepted, whereas for hippuric acid only 48% are above the recommended values.

Metabolite	ACGIH 2014
o-cresol	0.3 mg/creat g
Hippuric acid	1.5 g/creat g

The result is important considering that workers should be evaluated by specialists in occupational health and actions depend, in part, from these data.

Foam and soil washing processes for contaminated soils using plant biosurfactant

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Abstract Type Poster

Abstract

The contaminated industrial soil contains 6511 mg/kg copper, 4955 mg/kg lead, and 15090 mg/kg zinc, respectively. The effectiveness of using the eco-friendly biodegradable surfactant saponin from soapberry for the removal of heavy metals from contaminated industrial soil by foam fractionation and a soil flushing process was evaluated under variation of fundamental factors. The removal of Pb, Cu and Zn was increased from 40–47%, 30–36% and 16–18% in presence of saponin with an increase in the incubation time from 24h to 72h at room temperature by the soil washing process at pH 4. In the foam fractionation process, the metal removal efficiencies were increased with increases in the saponin concentration (0.075–0.150 g/L) and incubation time (24–72h), whereas the efficiency was decreased with increasing pH (4-10) and temperature (>40°C). The removal efficiencies of Pb, Cu and Zn were increased significantly from 57–98%, 85–95% and 55–56% with an increase in the flow rate from 0.2 to 1.0 l/min at 0.150 g/L saponin (pH 4 and 30°C). The present investigation indicated that the foam fractionation process is more efficient for the removal of heavy metal from contaminated industrial soil in comparison to the soil washing process. The plant-based eco-friendly biodegradable biosurfactant saponin can be used for environmental cleanup and pollution management.

Environmental health impact of emissions from industrial activities in the vicinity of Umlazi Township, South of Durban, KwaZulu-Natal Province (South Africa)

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Abstract Type Poster

Abstract

The Umlazi Township of South Durban, a mixed industrial and residential district of KwaZulu Natal Province of South Africa, is a Township of critical environmental concern. Diverse industries in South Durban include those of transportation, petroleum refining, chemical, paper, sugar, plastics, textiles, galvanizing and paint producing. There are also scrap yards, sewage treatment plants, and solid waste management installations. Pollution from these industries takes many forms, with the most potent fugitive emissions coming from the transportation industry. This is unsurprising, given the large volume of aging traffic in Umlazi. Other industrial processes such as combustion of fossil fuels (coal, oil, and natural gas) and biomass use for energy generation at homes, have resulted in escalating levels of NO_2 and O_3 as well. Because previous studies on noxious emissions from this highly industrialized Township have focussed largely on the fate of SO_2, it is believed that a more circumspect approach engendering a look at exposure outcomes of other fugitive components of industrial emissions in the Township, specifically CO, O_3 and NO_2, is desirable. Continuous monitoring of the air quality was performed using an Extract, Transform and Load (ETL) gas analyser, and an environmental air quality monitor, in order to determine the public health consequences of high emission levels of these polluting oxides in ambient air. The implications of recorded high average levels of NO_2 and O_3 at 76.0 $\mu g/m^3$ and 44.3 $\mu g/m^3$, respectively, are explained and measures for minimizing the effects of these pollutants are proposed. It is hoped that results from this study would aid in the formulation of plans aimed at improving the air quality for the well-being of residents living in close proximity of these industrial zones in the Township.

Some dependence of index of haemoglobin on the geophysical features of place of residence

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Abstract Type Poster

Abstract

A natural electromagnetic field of the Earth - is widespread regionally, for example, in the zones of deep-seated faults of the earth's crust (Sinyakov, 1984). A heightened electroconductivity of the medium, connected with the lack of dielectric durability in certain local capacities, is most peculiar to the regions of the pronounced geotectonic activation. There is a proof of the presence of special guantum currents which close in the place of tectonic faults. The tectonics of the Aral-Caspian region has also attracted many researchers' attention long since: it is the place where one of the most important tectonic centres is situated (Charygin et al., 1963). Intensive positive anomalies round the Caspian Depression from the South. The majority of anomalies is characterized by the intencity up to 300-500 nTl and creates a cellular structure. Anomalous developments of the natural variable terrestrial magnetic field influence human magnetic field and alter characteristics of his biomagnetic field.

The haemoglobin (Hb) contains an iron atom (62-70% of Fe are in red corpusclus Hb), which has a great magnetic moment. Deformation of red corpuscles during lots of pathological processes can be caused by chandes, connected with the intracellular Hb. We've found out that the residents of the North-Eastern Caspian Region have a heterogeneous microcytosis, anisocytosis (heterogeneity in the volume of red corpusclus), decrease of MCHC indicators (average Hb concentration in red corpusclus) that is typical of haemoglobinopathies. The most frequent were: more hypochromic red corpusclus in 28%, amond them ovalocytes (a change in the volume of red corpusclus) accounted for 21%, more target cells 25% (up to 14% per field of vision), 21% with an oxidative stress. We should pay attention to a frequent combination of the above stated changes. These changes do not exclude haemoglobinopathies, which are based on the decrease of polypeptide chains synthesis, which are the part of a normal HbA structure.

It is proved that the structure of polypeptide haematohistone chains is programmed in the molecule of normoblast nuclear. It gives us an opportunity to make a conclusion that the change of one type Hb synthesis for another doesn't meam the change of erythropoiesis types but is likely to depend on activation of one gene locuses and partial repression of the others.

Possible health impact of the alkaline Pilanesberg Complex on communities in the semi-arid region of the North West Province (South Africa)

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Abstract Type Poster

Abstract

South Africa like many other African countries has naturally occurring geological problems that can have an indirect or direct influence on human and animal health. However, data of such problems are very few or do non-existent for some localities. Rigorous studies are therefore needed to examine the possible connection between the geology of a specific area and its health problems. The study area is semi-arid and is situated nearly south of the Kalahari Desert and is about 60 km northwest of the Rustenburg town in the North West Province. In this study, particular focus is given to the possible link between the geology of the alkaline Pilanesberg Complex and the mafic Rustenburg Layered Suite in the area and the health of communities residing there. In this locality, almost all communities rely on groundwater for domestic use. Data from previous reports as well as preliminary results from some groundwater samples indicate high concentrations in F, Ca, Na, U and total dissolved solids (TDS). Previous reports show that the concentrations of these elements are about 10 times more than the allowable limits published by the South African Department of Water Affairs and the World Health Organisation. According to the South African mortality profile report of the North West Province, skeletal fluorosis, cardiovascular related diseases, renal diseases and diarrhoea are prevalent. In addition to this, local health data from the study area show a prevalence of hypertension (which may be coupled with musculoskeletal and mental disorders), diarrhoea and menstrual cycle disorders. Providing holistic-approach solutions to help communities with preventative measures to healthier living conditions is also important for this investigation.

Potential harmful trace elements (PHTEs) in borehole water of rural Greater Giyani area Limpopo (South Africa): possible implications for human health

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Abstract Type Poster

Abstract

Most rural communities in developing countries rely on borehole water as their only source of water supply. Although groundwater is extensively utilised, many remote communities still use untreated borehole water and the knowledge on the possible presence and distribution of Potentially Harmful Trace Elements (PHTEs) levels is still limited or even unknown. The objectives of our investigation is to assess concentration levels of PHTEs and their spatial distribution patterns in borehole water in the Greater Giyani area Limpopo, South Africa and the potential associated human health risks thereof. Twenty nine borehole water samples, including 15 community boreholes and 14 primary school boreholes were collected from this area. The samples were analysed for trace elements Arsenic (As), Cadmium (Cd), Chromium (Cr), Selenium (Se), Lead (Pb) and Uranium (U) using the inductively coupled plasma mass-spectrometry (ICPMS) technique. The concentrations of As, Cd, Cr, Pb and Se vary from 4.0 to 112.3, 0.2 to 0.9, 10.5 to 69.5, 6.0 to 19.0 and 0.4 to 18.8 µg/L respectively. Arsenic, Cr, and Se slightly exceeded South African National Standard (SANS) permissible limits for drinking water in several boreholes while Cd displayed low concentration in all sampled boreholes. Lead was found to be present at limits of detection in 96.6% of sampled boreholes. Nearly 13% of boreholes in the area had As concentration of more than two times SANS permissible limit for drinking water with one sample containing five times more As than the SANS acceptable limit for drinking water. To assess the potential risks associated to exposure to inorganic As health data was evaluated. The data comprises a total of 100 cancer incidence and 66 mortality rates during the period 2011-2014 obtained from Nkhensani Hospital. Only 6 out of 100 cancer incidences and 2 out of 66 mortality rates were observed in arsenic hot spots. The findings of the study indicate that As occurs in elevated levels in several boreholes in the study area. Although, a few cancer incidences and mortalities due to cancer were observed in arsenic hot spots overall, our investigation does not reveal a clear correlation between health effects and high As levels in borehole water of Greater Giyani area.

Natural radiation in the Vila Pouca de Aguiar-Vidago granite massif (N Portugal): geological constraints and radon risk

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Abstract Type Poster

Abstract

Exposure to natural radiation, in particular the radon gas, is an environmental risk to the general population, which is variable depending on various geological factors. In this sense, the present study systematises the results of exposure to natural radioactivity associated with the granite massif in Vila Pouca de Aguiar-Vidago (Northern Portugal), evaluating the radiological background through a portable gamma-ray spectrometer GF Instruments — Gamma Surveyor compact 2, equipped with a NaI detector (n = 84) and relating it to measurements of radon gas activity inside homes obtained with CR39 passive detectors (n = 91). The post-tectonic granite massif has an elongated form, shaped by NNE-SSW fractures, consisting of three types of biotite granite (Souto, Telões and Pedras Salgadas) and different stages of change. With regard to dose rate by external radiation exposure, the average values for the granite of Pedras Salgadas) (224 ηGy/h) and Telões (231 ηGy/h) were slightly higher than that most frequently recorded for granitic rocks of ZCI (ca. 200 ηGy/h). The results of K, U and Th were always higher than the average crustal abundance of these elements (ca. K 3%; U 3 mg/kg; Th 11 mg/kg). The highest levels of uranium and thorium that occur respectively in the episienitized granite of Telões (U = 18.5 mg/kg) and Pedras Salgadas (Th = 28 mg/kg) can be related to the presence of these elements in radioactive accessory minerals, especially zircon and allanite in the granite of Telões (rare allanite), and monazite and xenotime in the granite of Pedras Salgadas, as well their movement along fractures and episienitization zones. The granite of Telões and Pedras Salgadas, including their changing stages are more radiogenic than the granite of the Souto boundary. The geometric mean of radon activity measured within 91 dwellings based on the three granites studied during winter are higher than the limit of 400 Bq/m^3 laid down by national legislation on indoor air quality; subsequently there are a significant proportion of dwellings that exceed this value (n = 57). Some higher values observed in newer homes may be related to their improved thermal isolation and energy performance, which reduces air exchange with the outside.

Water manganese and mercury levels relationship with these metal biomarkers in school-aged children living in the Nangaritza River basin (Southern Ecuador)

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Abstract Type Poster

Abstract

Small-scale gold mining activities carried out in high mountain areas and in alluvial areas at the Southern Ecuadorian Amazon have incorporated several heavy metals into the aquatic systems, causing serious damage to aquatic biota and increasing the risk of exposure of populations living in adjacent areas. These heavy metals have been used during the gold extraction process (elemental Hg) or may be derived from lithologic sources (Mn, Pb, etc). This kind of contamination may cause serious damage to human health, when these waters are used to drink, cooking or bathing; especially to the central nervous system and kidneys. Thus, the objective of this work was to evaluate the levels of contamination by Hg and Mn in several rivers of the Nangaritza River basin and investigate its relationship with Hg in urine (HgU) and Mn in hair (MnH) levels in school-aged children residing in that area, since elemental Hg is used in the artisanal gold extraction and Mn is present in the ore coming from the stone in high concentrations. River water samples were collected from a high contamination zone (HEx, High Exposure zone) and from a moderate pollution zone (MEx, Moderate Exposure zone). The concentration of Mn in waters was measured by flame atomic absorption spectrometry (AAS), whereas the Hg levels in waters were determined by AAS with the cold vapor method. After informed consent of parents or legal guardians was obtained, hair and urine samples of children were collected for Mn and Hg analyses, respectively. The hair and urine samples were digested using standardized techniques. The concentrations of MnH were measured by graphite furnace AAS, whereas the concentrations of HgU were determined by the cold vapor technique. The results showed high concentrations of Hg and Mn (mean of 1.2 µg/L and 3.3 mg/L, respectively) in the rivers of the HEx zone, probably due to the effect of the effluent coming from the mining sector, which showed concentrations of 109 µg/L of Hg and 26.08 mg/L of Mn. On the other hand, the levels of Hg and Mn in the MEx zone were lower than those of the HEx zone, with concentrations lower than 1 µg/L of Hg and 0.2 mg/L of Mn. The means and the standard deviations (±SD) of MnH and HgU levels in children living in the HEx zone were 7.30 µg/g (±5.90) and 10.94 µg/g creat (±19.94), respectively; whereas in children residing in the MEx zone showed values of 4.94 µg/g (±6.29) of MnH and 1.43 µg/g creat (±3.76) of HgU. There is a relationship between the concentrations of Mn and Hg measured in waters and the levels of Mn and Hg biomarkers in children of the studied zones. Also, we found highly significant differences ($p < 0.001$) in the concentrations of MnH and HgU levels between the school-aged children living in the two distinct exposure zones.

Characterization and potential toxicity of fibrous amphibole minerals near the Las Vegas Metropolitan Area

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Abstract Type Poster

Abstract

Fibrous amphibole minerals are known to cause malignant mesothelioma, asbestosis, pleural fibrosis, and lung, ovarian, and larynx cancers and have additionally been linked to depressed immune function, cardiovascular disease, gastrointestinal cancer, and several autoimmune diseases (Agency for Toxic Substances and Disease Registry, 2001; Liu, et al., 2013; Camargo, et al., 2011; Shannahan, 2011; International Agency for Research on Cancer, 2012; Marchand, et al., 2011). The Wilson Ridge pluton (WRP) in northwest Mohave County, Arizona has recently been identified as a source of fibrous actinolite, magnesiohornblende, and $NaFe^{3+}$-amphiboles (winchite, magnesioriebeckite, and richterite). WRP is a synextensional, calc-alkaline pluton that formed in 13.7 – 12.5 Ma. Subsequent faulting and dike emplacement from regional extensional forces, along with adjacent halite deposits, resulted in Na-metasomatism and the formation of fibrous amphibole minerals in parts of WRP. There is significant potential for human exposure to these fibrous amphiboles because WRP is less than 15 km from the Las Vegas metropolitan area, where over 1.9 million people live. This study characterizes the mineralogy and morphology of this newly discovered fibrous mineral source. A total of 59 subsamples were collected from fracture fill surfaces, veins, and replacement minerals of magmatic hornblende in the rock matrix in 35 rock samples collected from 15 locations. Fibrous amphiboles were identified in every sample. Preliminary electron dispersive spectral data show that isolated amphibole mineral particles (>3000 in total) include actinolite, magnesiohornblende, and other amphiboles similar to those found at the Libby, Montana USEPA Superfund Site (magnesioriebeckite, winchite, and richterite). SEM imaging shows that particle morphology ranges primarily between thick fiber bundles and elongated, thin fibers, with some prismatic crystals. Fibers range from about 0.3 to 1.2 um wide and 2 to >100 um long. The length-to-width aspect ratios of fibers range from about 3:1 to >100:1. A 3:1 ratio is considered a toxicity threshold for asbestos fibers. Amphibole fibers from veins and fracture fill surfaces have aspect ratios significantly higher than replacement amphiboles within the rock matrix. The source rocks containing the fibrous amphiboles have been eroded and deposited in surrounding alluvial fans. Many of these areas are used for recreational activities including hiking, off-road-vehicle recreation, horseback riding, and water recreation in and around the Lake Mead National Recreational Area. The arid climate of the region also significantly increases the potential for human exposures because most soils lack vegetation and dust is generated by both wind and anthropogenic activities. Our results show that fibrous and asbestiform amphiboles eroding from the WRP are capable of air transport and human inhalation, potentially affecting the nearby 1.9 people in the Las Vegas metropolitan area.

Mercury concentration in road dust samples of Mexico City

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Abstract Type Poster

Abstract

The anthropogenic emissions are leading to a general increase of mercury concentration in the environment. Urban areas are particularly affected since they are exposed to a wide diversity of sources. Chemical information obtained from monitoring programs is relevant to identify emission and assess their impact. Atmospheric mercury deposited on dust might be a good indicator of extent of Hg accumulation in the urban environment, further they represent an important effect to human health, due to the complex chemistry and the possibility of re-emission. In Mexico City information concerning local Hg sources is scarce. This research aims to assess the mercury concentration in dust samples collected in the metropolitan area of Mexico City. The analyzed samples showed concentration values up to 800 mg/kg.

Investigation of Hg and Zn contamination in agricultural soils of an industrial area: a case of public health?

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Abstract Type Poster

Abstract

The main purpose of this study was to evaluate the concentrations of Hg and Zn in soils and its transfer to horticultural crops that grow around the Estarreja Chemical Complex (ECC), acting in two ways: a first sampling survey covering an area of 20 Km^2 around the ECC and a second focus on small farms that showed outlying concentrations in foodstuffs in the previous survey. At the end the data will be integrated in order to ascertain possible relationships to public health problems. In Estarreja the contamination is chiefly related to past industrial activities. Some rehabilitation works have been implemented since 2003 but for many years the liquid effluents were discharged in the sewage outlet coming from the factories and the solid wastes were deposited on the soil. Pollution of agricultural soils is a concern as it can affect foodstuffs quality and safety and even human/animal health. Soil samples were collected from urban areas as Estarreja in 2011 (25 sites), 2013 (22 sites) and 2014 (10 sites) and in Ouca (reference site). The foodstuffs (mainly tomato and cabbage) were collected in all sample sites in 2011 and where available in the 2013 and 2014 campaigns. In the last two surveys the groundwater (used for irrigation of crops) was analyzed too. The soils, vegetation and groundwater samples were analyzed for 32 elements by ICP-MS and for pH. In addition to contents extracted with aqua regia, all soil samples from 1st survey and in some selected points from the other campaigns, were leached with ammonium acetate in order to assess the bioavailability of Hg and Zn. The results of the 1st survey show that for Hg only 7.6% of the soils exceed the Health Canadian Soil Guidelines for agricultural purposes and for Zn none of the soils samples exceed the proposed value. However, for all soils the available Zn fractions were higher than the trigger value proposed by the Germany legislation. For Hg, the available fraction was very low. The Hg and Zn contents in foodstuffs vary significantly but usually are higher than those reported in the literature for industrial sites and in some cases exceed what is considered excessive or toxic concentrations. The spatial distribution of Hg and Zn shows that the highest contents in cabbage (e.g. Hg, 80 µg/kg and Zn, 183 mg/kg) and tomato (e.g. Hg, 20 µg/kg and Zn, 44 mg/kg) are found in small farms away from the ECC (approximately 2-5 km) which is not a typical anthropogenic model of distribution of contaminants. The 2013 and 2014 surveys confirm these results and in one small farm the content found in foodstuffs and soil was nearly the double which can not be related to the past contamination. One possible explanation is that in nowadays the farmer is mixing the residual soil with the sediments from the cleaning operations of the Estarreja Esteiro (which in the past receive effluents from the ECC).The impact of these very high levels in Hg and Zn on health of the foodstuffs consumers should be investigated.

Polycyclic aromatic hydrocarbons in soils from Estarreja urban area: a myth or a reality?

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Abstract Type Poster

Abstract

The Estarreja urban area has been subjected to the surrounding industrial impact of the Chemical Complex (CC) for several decades. The intense industrial pollution release of solid waste, wastewater and/or gas containing various chemical species, both organic and inorganic, may be harmful to the environment and human health. Several studies report the presence of potentially harmful elements to human and animal health, in soils located near the CC and around one of the sewage outlets (S. Filipe outlet), which are also areas of high agricultural activity. The present study deals with the distribution and identification of possible sources of a large number of organic compounds in soils, but here it will be only presented the results for 16 individual polycyclic aromatic hydrocarbons (PAHs), a group of toxic compounds released to the environment through natural processes and anthropogenic activities. Soil samples were collected from the urban areas of Estarreja and Ouca (a blank site) in September 2013 (26 sites) and 2014 (10 sites). In the reference area the PAHs were not detected as expected. In Estarreja, 10 PAHs (max ΣPAHs: 0.52 mg/kg) were detected in 42% of the soil samples. One of them is located inside the CC. Fluoranthene (Flp) and pyrene (Pyr) were the only PAHs that were detected in all of these sampled soils. These organic compounds are usually associated with the combustion of fossil fuel and other burnable materials. Individual PHAs concentrations are in almost all the soils lower than the available Canadian environmental health guideline values set for agricultural soils, except for Flp and Pyr that exceed slightly the guideline (0.1 mg/kg). These soils were in the past and nowadays mixed with the fine sediments that came from the cleaning operations of the Estarreja Esteiro which receives effluents from the CC. Potentially carcinogenic PAHs were only detected in two sampling locations, one of them in CC area ((benzo (b) fluoranthene: 0.05 mg/kg) and the other near a traffic road (Σ 5 PAHs: 0.46 mg/kg). Comparing the data of 2013 with data of 2014 the results did not change, although there is a new sampling location with the previous identified potentially carcinogenic PAHs (Σ 5 PAHs: 0.26 mg/kg). The results of this study provide a useful baseline for evaluating future trends in PAH soil concentrations, as although this study indicates that PAH soil contamination from anthropogenic sources is not a concern, it will be recommended that some points should continue to be monitored.

Potential health impacts of groundwater in a non-exploited uranium ore: the case of Horta da Vilariça (NE Portugal)

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Abstract Type Poster

Abstract

The anomalous concentrations of chemical elements in rocks can be a source of health effects for the human population even in the absence of exploitation activities as shown in previous research studies. In the Horta da Vilariça region (Torre de Moncorvo, Northern Portugal) outcrops an U ore located in the metamorphic aureole of a hercynian granite; the host rocks are metasedimentary schists and greywacks of the pre-ordovician "Complexo Xisto-Grauváquico" and the source of the mineralization are uranium phosphates. The groundwater percolation in the ore is controlled by fractures, joints and the schistosity of the metasedimentary rocks. To evaluate the water-rock transfer of the chemical elements 11 groundwater wells, with a depth between 42 and 75 meters, were sampled in the area. Analysis of major and trace cations, were performed by OES-ICP and AAS; anions by chromatography; ^{222}Rn, ^{226}Ra, ^{234}U, ^{238}U and total U, by LSC (liquid scintillation counting); As speciation measurements were also carried out by Square Wave Cathodic Stripping Voltammetry. Analytical results point to Ca-Na bicarbonate groundwaters with a mean electrical conductivity of 536 µS/cm, and pH between 5.9 and 6.8. The concentration of dissolved As reaches 15 µg/L, mostly in the oxidized form of As(V), and is above Maximum Admissible Value for drinking water in 3 wells used for drinking and/or irrigation. The radioisotopes concentrations are also very high in most of the water samples in particular for U and Rn: 65% of the samples are above the WHO recommended limit for drinking water in respect to U (20 mg/L), being 129 mg/L the median value and 3483 mg/L the maximum value measured; 30% of the samples are above the EU recommended limit for drinking water for Rn (1000 Bq/L), being 400 Bq/L the median value and 9784 Bq/L the maximum value measured. The evaluation of the human exposure to ionizing radiations was performed through calculation of the total annual dose by ingestion of water in different age groups of the population. The results indicate that in 60% of the samples the total effective dose exceeds the limits suggested by WHO guidelines and EU Directive (0.1 mSv/y). In one specific case water consumption for a newly born child (<1 year) can result in an effective dose of ca. 10 mSv/y. In face of the results obtained in the present geochemical survey it is recommended that the use of groundwater in the region should require a previous evaluation (for drinking as well as for crop irrigation), due to the high probability of occurrence of concentrations above the critical levels of natural chemical contaminants in particular U, Rn and As.

Water quality in the upper zone of the Conchos River in Chihuahua (Mexico)

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Abstract Type Poster

Abstract

The rivers have been considered as one of the most productive ecosystem on Earth. The Conchos River located in the north of Mexico has been an ecological site for a variety of wildlife species as well as a water supplier for local inhabitants. As a consequence, different dams have been built to retain this natural resource; for instance, the La Boquilla dam is the largest one in Chihuahua, Mexico. This reservoir captions the water from the Conchos River. The objective of this study was to determine the water quality in terms of physicochemical and metals/metalloids parameters at three locations points of the upper Conchos River; before the water is captioned in La Boquilla dam (before), in the dam, and after being released from the dam (after). Thirty randomly water samples were obtained in Valle de Zaragoza (before), 20 samples in the dam, and 30 samples in San Francisco de Conchos (after). The measured parameters were: pH, electrical conductivity (EC), total dissolved solids (TDS) temperature (T) and the following metals and metalloids: Al, B, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Se, Si and Zn. An analysis of variance (ANOVA) was conducted for each parameter using a significance level of 0.05 and once the statistical difference between locations was found, the Bonferroni test was performed. The results showed that, before flowing into the dam, the upper Conchos River was seriously affected, La Boquilla dam was less impacted, and the least tainted was the (after) San Francisco de Conchos, but not in all its sites. It could be considered that pollution due to agriculture, livestock, and mining activities was the main source which affected the quality of the water in the three locations. Consequently, human health could be affected by this contamination, for instance, skin cancer and lung cancer. Therefore, it is highly recommended to continue monitoring water in this area as well as to continue planning remediation strategies for the future.

Population health risk due to the consumption of medicinal plant *Malva sylvestris L.*, growning in and around sites contaminated by toxic heavy metals

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Abstract Type Poster

Abstract

In order to assess the possible health risks associated with consumption of medicinal plants growing in contaminated sites, the contamination of trace metals in *Malva sylvestris L.*, have been studied. Plants and soil from different locations were collected and analyzed. The soil samples and also the plant samples have been made during the winter season spring and summer. The study for the determination of the content of heavy metals was carried out in the different organs of the plant and crop soils by atomic absorption spectrometer (AAS). According to the results, the leaves of *Malva sylvestris L.*, show that the concentration of copper (43.58 µg/g) and the concentration of zinc (437.42 µg/g), these concentrations are significantly higher than the WHO[1] data values. The concentration of heavy metals obtained in the leaves vary in a following decreasing order: Cu > Zn > Pb > Cd >Cr. A significant concentration of trace metals was determined in various samples of soils (186 µg/g). The results obtained of the total content of metal in the different parts: roots, stems and leaves, showed show a significant increase of metals especially zinc and copper from all parts of the plant *Malva sylvestris L.* and that humans could be at risk if they consume these medicinal plants from waste sites and waste disposal sites. This study show that harvesting / consuming the plant growing around a waste disposal site can be extremely dangerous.

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Bioaccessibility of platinum group elements from gasoline and diesel catalysts

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Abstract Type Poster

Abstract

Motor vehicles represent an important source of dispersed environmental contamination. The catalysts contribute to the contamination due to mechanical abrasion or catalyst deterioration. As a result, platinum group elements (PGEs) are emitted with exhaust gases in particulate form to the environment. In addition, they can be mobile and accumulate in living organisms including human being. In our research, we focused on bioaccessibility of PGEs from gasoline and diesel catalysts. We used dust from two crushed gasoline, two crushed diesel catalysts (new and aged) and certified reference material - recycled catalyst NIST 2556. While catalysts for gasoline engines contain a mixture of Pt-Pd-Rh, catalysts for diesel engines are composed only of Pt. For evaluation of bioaccessible PGEs from ground catalysts we used standard physiologically based extraction test (PBET) that simulates, sequentially, chemical conditions in the stomach and intestine of children. The experiment was carried out under predefined pH 1, 2.5 and 4 covering fasting and fed conditions at a stomach. After one hour, the stomach phase was removed and stored. The bicarbonate solution was added to attain neutral conditions of intestinal phase. Final solutions were analysed by ICP-MS. The percentage of bioaccessible PGEs from catalysts were in the following order: Pd > Rh > Pt. The Pt leaching slightly increased from stomach to intestinal phases. However the leaching of Pd and Rh slightly decreased from stomach to intestine. The bioaccessibility in the stomach is similar from pH 2.5 to 4, but increases greatly at pH 1. The solubilization of PGEs in the human digestive tract may form PGEs-chloride complexes, which have toxic and allergenic effect.

Are soil micronutrient imbalances due to dispersed mineralization a cofactor in malnutrition in Limpopo Province (South Africa)?

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Abstract Type Poster

Abstract

In recent years substantial additional data have been acquired on the geochemical behavior of some nutritional (e.g., Fe, Zn and Se) and potentially harmful elements (PHEs) (e.g., As, Hg and Pb) in the soils of Limpopo Province of South Africa. This has provided further insights into possible causes of widespread malnutrition, among other existing environmental health conditions. Limpopo is the northernmost province of South Africa, with just over 5 million people. The Province is endowed with abundant agricultural resources and it is one of the country's prime agricultural regions. Ironically, Limpopo is the South African province with the highest level of poverty, with malnutrition still a prevalent problem in the Province. Many people live close to the land, practicing subsistence farming; and agriculturally based people tend to have the most inadequate diet. The prevalence of malnutrition in Limpopo is so vast that 48 percent of children in the Province evaluated in a 2005 study were shown to have stunted growth. Limpopo is also well endowed with a wide variety of mineralization types. The larger mining operations in the Province are for the platinum group metals, iron ore, chromium, coking coal, diamonds, and so on. Limpopo Province has diverse soils, which vary in productivity depending to some extent on the geochemical imprint imparted by mineralization events, followed on a more recent time scale by mining and related processes. The generally high acidity, together with the highly organic-rich nature of the soils leads invariably to mobilization (and loss) of some important micronutrients, leading to deficiency. Examples of data accrued on malnutrition and micronutrient correlates in Limpopo include the high prevalence of stunting and overweight accompanied by serum deficiencies of Fe, folate and vitamin B12 in children of the central region of Limpopo, at ages 1 and 3 years, explained by their diet; attribution of high levels of abortion in goat herds due to Zn and Se deficiencies (up to 12.5 and 5000 times lower than the minimum expected), in Vhembe District, Limpopo. The widespread incidence of geophagy may also be taken as evidence of compensation for some micronutrient deficiency such as Fe and Zn. If soil micronutrient imbalances due to mineralization and mining are proven to be an important cofactor in malnutrition in Limpopo, this would enable intervention strategies on supplementation and appropriate fertilizer application to be much more easily and much more confidently applied.

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02

Environmental toxicology, pathology and epidemiology

Tolerance mechanisms of *Hypoxis hemerocallidea* exposed to cadmium and aluminium stresses and their implications in safety and quality of medicinal products

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Abstract Type Oral Presentation

Abstract

Hypoxis hemerocallidea is one of the most frequently utilized medicinal plants with diverse pharmacological properties. The high demand for this plant species has led to a drastic detrimental pressure on the wide population due to destructive harvesting of plant material and with high possibilities of heavy metal contamination from increasing anthropogenic activities. This study investigated the tolerance mechanisms of *H. hemerocallidea* to Cd and Al stress as well their effects on safety and quality of medicinal products. Regenerant of *H. hemerocallidea* were acclimatized for 7 months and treated with Cd and Al, both singly and in combination for 6 weeks. *H. hemerocallidea* accumulated high amounts of Cd and Al (48 and 1009 mg/L respectively) in corms which were above the WHO safety limits. Increasing concentrations of these heavy metals significantly reduced plant biomass compared with the controls. Metal toxicity was evident in the high amounts of free proline accumulation and high levels of antioxidant enzymes (superoxide dismutase and malondialdehyde) were recorded in all the metal treated plants. Chlorophyll fluorescence analysis revealed a significant decrease in the activity of photosystem II in most of the treated plants. Light microscopy, scanning and transmission, and electron microscopy reveal ultrastructure defects particularly on chloroplast and cell wall structures at high levels of heavy metal treatments and this could have been responsible for the decreased in photosynthetic pigments. Plants treated with Cd and Al showed high levels of total sugar accumulation with reduced amylase enzymes compared to the controls. Phytochemical screening and high performance liquid chromatography analysis showed a decrease in the amounts of secondary metabolites among some of the treated plants. These highlight the needs for urgent monitoring of heavy metals in medicinal plants to ensure the safety, quality and efficacy of Hypoxis medicinal products.

Iodine environmental bioavailability and human intake in oceanic Islands

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Abstract Type Oral Presentation

Abstract

Iodine deficiency is the most common cause of preventable mental impairment worldwide and poses as a major public health problem. Iodine environmental bioavailability is different in various regions of the world, mainly because iodine soil concentrations can be affected by the repeated leaching effects of water and heavy rainfall. The highest values of iodine are found near the coast because it is released from the ocean by volatilization of seawater iodine into the atmosphere. However living near of the sea coast does not guarantee human iodine adequacy and significant pockets of iodine deficiency (UIC <100 µg/L) have been reported for inhabitants of coastal regions and oceanic islands in different parts of the world. Recent studies have shown that the inhabitants of the Azorean Islands have a mild iodine deficiency; in the eastern group urine iodine concentration (UIC) ranged from 70.9 mg/L in São Miguel to 88.0 mg/L in Santa Maria. In this particular context, the objectives of this study were to (i) evaluate iodine concentrations in soil, grass and water samples (ii) assess the environmental factors that may be related with iodine bioavailability and human intake and, (iii) assess UIC in school children. The study was conducted in São Miguel (study area) and Santa Maria (reference area) Islands (Azores, Portugal). Iodine concentrations in soil and grass pasture were measured by Instrumental Neutron Activation Analysis (INAA) and, in drinking water by spectrophotometry. Iodine intake in school children was assessed in a cross-sectional survey with 315 participants. Socio-economical factors and a validated diet questionnaire assessing sources of iodine were recorded. The UIC was assessed by Inductively Coupled Plasma/Mass Spectrometry (ICP-MS). Data were analyzed with logistic regression models, adjusting for age, residence time, dairy products and meat consumption. The iodine concentration in soil of the reference area was significantly higher than in the study area (58.1 mg/kg vs. 14.5 mg/kg) respectively; $p = 0.001$); however no significant differences were observed in iodine content of grass pasture and of drinking water from both islands. The prevalence of schoolchildren with inadequate urinary iodine (<100 mg/L) in the study group was significantly higher than in the reference group (63.0% vs. 37.8%, respectively; $p < 0.001$). Chronic exposure to low iodine availability in soils was significantly associated with the exacerbation in iodine deficiency and the risk was significantly increased in the study group (4.94 times higher). Environmental factors such orography, rainfall and wind can be related to the differences in iodine availability in soils of both islands and, thus with differences in human intake. These findings draw attention to the urgent need for a comprehensive investigation of Azores iodine status and implementation of evidence-based recommendations for iodine supplementation.

Nitrate in drinking water: using Danish register data to investigate possible health effects with focus on gastrointestinal cancers

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Abstract Type Oral Presentation

Abstract

Annual nationwide exposure maps for nitrate in drinking water in Denmark from the 1970s until today will be presented based on the findings in Schullehner & Hansen (2014) and additional work on addressing the issue of private well users and estimating missing data.

Drinking water supply in Denmark is highly decentralized and fully relying on simple treated groundwater. At the same time, Denmark has an intensive agriculture, making groundwater resources prone to nitrate pollution. Drinking water quality data covering the entire country for over 35 years are registered in the public database Jupiter. In order to create annual maps of drinking water quality, these data had to be linked to 2,852 water supply areas, which were for the first time digitized, collected in one dataset and connected to the Jupiter database.

Analyses of the drinking water quality maps showed that public water supplies are extensively registered, while private wells supplying only a few households are neither monitored nor registered in a systematic manner. It was calculated that 5.1% of the Danish population was exposed to elevated nitrate concentrations above 25 mg/L in 2012. Private well users were far more prone to exposure to elevated nitrate concentrations than consumers connected to public supplies. While the fraction exposed to elevated nitrate concentrations amongst public supply users has been decreasing since the 1970s, it has been increasing amongst private well users, leading to the hypothesis that the decrease in nitrate concentrations in drinking water is mainly due to structural changes and not improvement of the groundwater quality as such. It can be seen from the analyses that throughout Denmark there is an adequate exposure contrast, with consumers being exposed to drinking water with nitrate concentrations over a range from as little as below the detection limit up to levels above the drinking water standard of 50 mg/L.

Elevated nitrate in drinking water has been associated with several kinds of cancer, e.g. colon cancer, however with ambivalent conclusions. These newly created nitrate concentration maps can now be combined with the exhaustive Danish registers on health and residence, permitting a long-term register based epidemiological study on the health effects of nitrate in drinking water.

References

Schullehner J and Hansen B 2014 Nitrate exposure from drinking water in Denmark over the last 35 years. Environ. Res. Lett. 9 095001.

The possible role of arsenic and heavy metals, herbicides and fertilizers in the incidence of chronic kidney disease of unknown etiology

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Abstract Type Oral Presentation

Abstract

Chronic kidney disease of unknown etiology (CKDu) is killing many people in Central America, Sri Lanka, Vietnam and other parts of the world. Recent investigations in Sri Lanka and El Salvador suggest that agrochemicals loaded with heavy metals and arsenic, together with the use of herbicides can be contributing to the occurrence of this disease. Important sources for arsenic and heavy metals are fertilizers that contain contaminated phosphates. Besides this, the application of phosphates to soils containing arsenic can produce the release of arsenic to the infiltrating waters and contamination of aquifers. This process is particularly important in volcanic regions of the world where arsenic occurs frequently in the eruption products. The use of herbicides and fertilizers has increased considerably around the world in the last few years. Some herbicides (e.g. glyphosate) have been suggested to decrease the capacity of the organism to detoxicate. In Sri Lanka and El Salvador, arsenic contaminated hard waters have been found in areas were people are suffering from the disease. In El Salvador, a clear geographically weighted correlation between this disease and agriculture suggests that the use of herbicides and other agrochemicals is playing an important role in producing the disease (especially sugar cane cultivation where large amounts of glyphosate are used). The previous facts suggest that a possible correlation between the use of agrochemicals containing heavy metals and arsenic, and herbicides could be producing the chronic kidney disease of unknown etiology. The interplay of fertilizers, herbicides and other pesticides, and the geological setting in the incidence of chronic kidney disease and other diseases need to be investigated further, and regulations that consider the risks of applying chemicals in different geological environments should be implemented.

Cytogenetic damage in oral epithelial cells of individuals chronically exposed to volcanogenic radon

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Abstract Type Oral Presentation

Abstract

Background: Geothermal areas are potentially one of the main hazardous zones to humans, as harmful gases like radon are continuously released from soil diffuse degassing. Exposure to radon and its decay products is estimated to be the second leading cause of lung cancer after tobacco smoke, but the health risks of radon ground gas emissions in geothermal areas are yet poorly known. Objectives: This population-based case–referent study was designed to evaluate the risk of cytogenetic damage in the oral epithelial cells of individuals chronically exposed to radon soil diffuse degassing (DDS) in geothermal areas. Methods: Oral epithelial cells were collected from 33 individuals inhabiting a geothermal area (study group) and 49 individuals inhabiting a non geothermal area (reference group). For each individual, 1000 oral epithelial cells were analyzed for the frequency of micronucleated cells (MNC) and the frequency of cells with other nuclear anomalies (ONA: pyknosis, karyolysis and karyorrhexis) by using the micronucleus assay. Information on life-style factors and an informed consent were obtained from each participant. Indoor radon was assessed with a radon detector and CO2 degassing was measured using portable instruments that perform measurements based on the accumulation chamber method. To estimate the association between exposure to volcanogenic radon and the frequency of MNC or ONA, relative risks (RRs) were calculated using logistic regression models, adjusted for age, gender and smoking status. Results: The average of indoor Rn was significantly higher in the geothermal area when compared with reference group (161 Bq/m^3 and 59 Bq/m^3, respectively). A positive exposure–response relation was observed between the degassing levels of indoor Rn or CO_2 and the frequency of MNC. The frequency of MNC in the study group was significantly higher than in the reference group (3.1‰ and 1.9‰, respectively), but for ONA no significant differences were observed. The risk of having a high frequency of MNC was 6.6-fold higher in the study group. The analyzed confounding factors (age, gender and smoking status) did not show any significant association with the frequency of MNC. Conclusion: Results show that there is a significant association between chronic exposure to soil diffuse degassing in geothermal areas and the occurrence of cytogenetic damage in human oral epithelial cells. Since MNC in oral epithelia are recognized as a predictive biomarker of cancer risk within a population of healthy subjects, the findings in this study evidence the carcinogenic potential of volcanogenic ground gas emissions.

Testicular damage in mice from organic and conventional farms in a volcanic region

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Abstract Type Oral Presentation

Abstract

The main goal of this study was to assess the effects of chronic exposure to different agricultural practices (conventional and organic farming) on male reproductive disruption, particularly testicular damage. Three groups of 12 male specimens of Mus musculus were captured alive, inside greenhouses, for later evaluation of testicular damage and determination of the internal hepatic doses of essential and trace metals (as biomarkers of exposure to both pesticides and fertilizers). The first group was captured in a conventional farm in which soils are frequently treated with agrochemicals. The second group was captured in a certified organic farm, where soil treatments are limited to organic fertilizers and the third group (control) was captured in a natural reserve forest that was never used for farming. Testicular damage was assessed by studying the relative volumetric density of different spermatogenic stages, of interstitial space and luminal space, the seminiferous tubules injury (based on qualitative scores), and by quantifying apoptotic spermatogenic cells in the seminiferous tubules (by TUNNEL assay). The proportion of interstitial space was significantly higher in the seminiferous tubules of mice from both farming sites in relation to control group, being greater in the conventional farming group. The proportion of late spermatids and sperm cells was significantly decreased in mice from the conventional farming group, which not only revealed a significantly increased amount of seminiferous tubules lacking sperm cells and with evidence of structural damage, but also a significantly increased amount of spermatogenic cells undergoing apoptosis, in comparison with the other two groups. These results suggest that both farming practices, especially conventional farming, enhance testicular damage in mice that are naturally and chronically exposed to trace metal enriched farming environments, confirming Mus musculus as an appropriate bioindicator of the potential effects and resulting risks for male fertility of farmers continually exposed to the same environments.

MEDGEO'15

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02

Environmental toxicology, pathology and epidemiology

Impact of exposure to cadmium on MG-63 osteosarcoma cells: a NMR metabolomics study

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Abstract Type Poster

Abstract

Exposure of an organism to an external stressor will result in metabolic variations and such variations can be used as indicators of an external stress. Therefore, metabolomics has potential as a sensitive and rapid technique that can reveal relationships between metabolite levels and an external stressor, such as contaminant exposure. Cadmium (Cd^{2+}) is a natural contaminant associated with nephrotoxic effects, at high exposure levels, and longer-term effects causing bone damage. The present study aimed at investigating the biochemical response of human osteoblast-like cells exposed to low Cd^{2+} levels in order to identify specific biomarkers for early detection of exposure to environmental Cd^{2+}. The tumoral cell line MG-63 was chosen as a model and a Nuclear Magnetic Resonance (NMR) metabolomics approach was followed to measure the cellular metabolic response to a 48 hour exposure to 20 and 50 µM Cd^{2+}.

^{1}H NMR High Resolution and Magic Angle Spinning (HRMAS) spectra were acquired for the lysed cell pellets and Principal Components Analysis (PCA) and Partial Least Squares-Discriminant Analysis (PLS-DA) were employed to compare controls (non-exposed) and exposed cell samples. PLS-DA models were validated through Monte Carlo Cross Validation and loading plots were interpreted in terms of varying levels of metabolites. Variations were quantified through signal integration and statistical significance evaluation ($p < 0.05$).

As expected, metabolite changes were generally more significant for the highest Cd dose of 50 µM. Statistically significant metabolite changes comprised decreases in glutamate, glutamine, taurine, adenosine/inosine, hypoxanthine, uridine, creatine, *myo*-inositol and *scyllo*-inositol, and increases in lysine and reduced glutathione (GSH), compared to controls. In addition to these variations in individual metabolites, a statistically significant decrease was observed for the GSH/GSSG (oxidised glutathione) ratio, which is often used as a marker of oxidative stress. Putative biochemical explanations are advanced for the observed effects of Cd on MG-63 cell metabolism.

This work shows that untargeted NMR metabolomics is a valuable tool to assess cellular behaviour towards contaminants and future steps should address the relationship between deviant metabolic behaviour and toxicity effects.

The association between arsenic in drinking water and Parkinson's disease in Taiwan

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Abstract Type Poster

Abstract

Introduction: Parkinson's disease (PD) is the second most common progressive neurodegenerative disease in Taiwan, next only to Alzheimer disease. The most common symptoms include resting tremors, rigidity, and bradykinesia. It is associated with the desecration of dopamine-generated neurons in the *substantia nigra* in the brain, but the actual etiology remains unknown. Some animal studies found that arsenic can pass through the blood brain barrier (BBB), aggregate in the *substantia nigra* area, and inhibit the synthesis and release of dopamine. Therefore, exposure to arsenic may be related to the occurrence of PD, but epidemiological data are still limited. We conduct a nationwide study to evaluate the association between arsenic exposure through drinking water and the association of PD in Taiwan. The NHIRD is managed by the National Health Research Institutes, and is maintained confidentiality according to the directives of the Bureau of NHI. Using data extracted from the Longitudinal Health Insurance Database (LHID2000), we conducted a retrospective cohort study of patients aged 40 years and older, who were newly diagnosed with PD (ICD-9-CM 332.0 or the equivalent A-code A221 before 2000; exclusion 332.1 secondary Parkinsonism) by a psychiatrist between January 1, 2000 and December 31, 2010. The duration during 1996-1999 was taken as wash-out and induction period. The index date for the PD patients was the date of their first medical visit for PD. We performed univariate and multivariate Cox proportional-hazards regression model, which were used to identify variables that predicted the length of time between the index date and the date of PD diagnosis after controlling for age and comorbidities (hypertension [ICD-9-CM 401–405], stroke [ICD-9-CM 430–438], and *diabetes mellitus* [ICD-9-CM 250, A-code A181]). Kaplan–Meier statistics was employed to evaluate the cumulative survival probability of PD between arsenic exposure areas. We used reports from a national census survey of wells conducted by the Taiwan Provincial Institute of Environmental Sanitation to assess arsenic levels in drinking water, which was using the standard mercuric bromide stain method. The survey measured arsenic levels in more than 80,000 wells, mostly between 1974 and 1976, and the original measurement reports were available for 311 townships covered almost whole townships in Taiwan. We divided all the townships of Taiwan into arsenic exposure endemic areas or not. Results: The hazard ratio of people living in the endemic areas of arsenic exposure was 1.42 compared to those who did not live in the areas, and the 95% confidence interval was 1.11-1.82, p = 0.004. However, the hazard ratio was not significant after we controlled for age and comorbidities (hypertension, stroke, and diabetes mellitus), HR = 1.07 fold 95% C.I = 0.84-1.37. Patients living in the endemic areas of arsenic exposure from drinking water had a higher risk of developing PD.

Naturally-occurring radioactive elements in bottled mineral waters and radiation dose to consumers

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Abstract Type Poster

Abstract

Bottled mineral waters, available from shelf in supermarkets, were analyzed for naturally-occurring radionuclides such as uranium (^{238}U, ^{235}U, ^{234}U) and thorium (^{232}Th, ^{230}Th) isotopes, radium (^{226}Ra), ^{210}Pb, ^{210}Po and tritium (^{3}H). Uranium (^{238}U) activity concentrations ranged from 0.2 to 297 mBq/L, ^{226}Ra varied from 0.5 to 949 mBq/L, radioactive lead (^{210}Pb) from 1.7 to 78 mBq/L and ^{210}Po from 1.2 to 75 mBq/L. Radionuclide concentrations did vary widely depending on the geological formation of the water source and chemical characteristics of water. Radionuclide activity concentrations particularly those of uranium, thorium, and radium were assessed in conjunction with dissolved salts and major ions present in water. Activity concentration ratios of uranium isotopes were determined and discussed in relationship with water hydrochemistry. Radioactivity intake through consumption of these waters by consumers was assessed. It was concluded that daily consumption of some of these waters may give rise to internal radiation doses above the recommended dose limit of 0.1 mSv/y for water consumption. Results are compared with data on other bottled waters in the European Union market, and discussed in the perspective of radiation protection of members of the public.

Distribution of hydrogeotoxicity due to arsenic and uranium in the southern part of Duero Basin (Spain)

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Abstract Type Poster

Abstract

In the southern part of the Duero Basin (Spain), naturally occurring arsenic and other Potentially Toxic Geogenic Trace Elements (PTGTE) sometimes occur in concentrations exceeding the limits for potable water. Usually, concentrations of these elements are only slightly above the limit, but this is sufficient to invalidate its use as drinking water. Geologically, the study area lies close to the central-southern edge of the Cenozoic Duero Basin (CDB), where a major lithological contrast occurs between the sedimentary basin and the igneous and meta-sedimentary basement of the Spanish Central System (SCS). Metalliferous minerals have been identified in the SCS, including rare occurrences of Pb, Cu and U ores, as well as W, Sn, As, Au, Zn and Ag ores. Secondary arsenic minerals, such as scorodite have been also recognized. Recent studies of small, now abandoned mines indicate highly toxic minor and trace elements (As, Cd, Tl and Hg) in the sulphides. The (CDB) is the most important aquifer of the region, and it is closely linked to the SCS along its SE edge. The main recharge to the CDB aquifer is via meteoric infiltration. Under natural conditions, the main discharge is to the River Duero, the largest drainage channel in the basin. The local climate is Mediterranean, although with a markedly continental character. Temperatures average 10.5–12°C and annual rainfall is 600 mm. Rainfall is lowest (≤400 mm) in the south of the basin, which is in the rain shadow of the SCS. Winters are cold (average winter temperature <5°C) and summers, short and arid. The general flow of groundwater in the southern fringe of the CDB is south to north, towards the River Duero. Hydrogeotoxicity or hydrogeotoxic risk (HGT) is defined as the quotient between the concentration of an element observed and the limit set by health regulations (such as the limits established by the WHO). Areas at risk of HGT from a given PTGTE are defined by values of this quotient greater than 1. One hundred and thirty water samples were collected along the southern edge of the Duero Basin (Provinces of Ávila and Salamanca, Spain). The redox and pH environment here is favorable to mobilization of arsenic and uranium. The primary origin of these elements in groundwaters is linked to natural sources, such as metalliferous minerals located in the Spanish Central System. In the water samples analyzed, the highest content in arsenic was usually associated with the highest concentrations in uranium. Hydrogeotoxicity of arsenic and uranium (HGTAs and HGTU) were calculated: 36% of water samples collected had HGTAs above 1, while only 5% carried a hydrogeotoxic risk due to U. Besides the HGT of arsenic, based on total concentrations, data on bioavailability of arsenic species were also considered to provide a comprehensive assessment of the hydrogeotoxic risk in the study area.

Attributable risk fractions of various risk factors for obstructive and restrictive ventilatory defects in a Korean population living near Portland cement plants

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Abstract Type Poster

Abstract

This study was performed to estimate the attributable risks (ARs) and attributable risk fractions in population (PARs) of demographic factors, lifestyle factors, and morbidity of respiratory and cardiac diseases in population living near Portland cement plants. Study subjects were 40 years old or older individuals who were living near Portland cement plants and those who resided in urban area (reference group) in Chungbuk Province, S. Korea. The subjects had undergone a spirometry test and chest radiography. The lower limit of normal of the USA National Health and Nutrition Examination Survey III was applied as criteria for spirometry tests, and the chest radiographic findings were classified into 12 diagnostic groups. Adjusted odds ratios for ventilatory defects were estimated for potential risk factors, and the relative risk, AR, and PAR were calculated using the age-standardized prevalence in the reference group. The prevalence of obstructive ventilatory defect was significantly higher in males, in aged people, and in smokers. Body mass index (BMI), asthma, pleural abnormality, tuberculosis, pneumoconiosis, emphysema, and bronchiectasis were significant risk factors for obstructive ventilatory defect. The risk factor with the highest AR for obstructive ventilatory defect was asthma followed by emphysema, bronchiectasis, and sex. However, sex was the risk factor with the highest PAR, and was followed by age and the cumulative smoking amount. Female sex, age, cigarette smoking, high BMI, asthma, pneumoconiosis, and heart abnormality were significant risk factors for restrictive ventilatory defect. The risk factor with the highest AR for restrictive ventilatory defect was heart abnormality; meanwhile, the risk factor with the highest PAR was the sex followed by age and smoking history. The AR of the distance between the cement plant and the residence was 13.1% for obstructive ventilatory defects. The AR of that distance for restrictive ventilatory defects was 16.5% in males, but negligible in females. Exposure to cement dust increased the prevalence of obstructive ventilatory defect by 1.0%. The prevalence of restrictive ventilatory defect was 3.7% higher in males exposed to cement dust, but not increased in exposed females. The sample size for a significant difference in the prevalence of obstructive ventilatory defect between the exposed group and the control group was estimated 7576 for each group despite that the level of exposure to cement dust was considerably high. The prevalence of pulmonary ventilatory defects changes with the population structure of subjects rather than the concentration or toxicity level of environmental pollutants. Age, sex, smoking habit, and BMI as well as the prevalence of asthma, pleural abnormality, tuberculosis, emphysema, bronchiectasis, and heart abnormality in subject population should be considered in epidemiological investigation in which spirometry is used.

Enrichment of arsenic in rivers originating from the Tibetan Plateau and effects on the local residents

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Abstract Type Poster

Abstract

Groundwater in sedimentary deposits in southwest China, South and Southeast Asia down gradient from the Tibetan plateau displays elevated As concentrations on a regional scale. Our study found enrichment of As in stream water (n = 86) of the Singe Tsangpo (upstream of the Indus River) and Yarlung Tsangpo (upstream of the Brahmaputra River). The average arsenic concentrations in stream water collected in June 2008 were 58.4±69.9 μg/L (n = 39, range 2.4-252.2 μg/L) for the Singe Tsangpo and 10.8±16.9 μg/L (n = 30, range 2.0-83.2 μg/L) for the Yarlung Tsangpo, respectively. A dug well contained 194.5 μg/L of As. Hot spring and alkaline salt lake water displayed very high As levels, reaching maximum values of 5,985 μg/L and 10,626 μg/L As, respectively. Additional water samples (n = 74) were obtained in August 2011 in these two drainages. The results confirmed As enrichment in the entire Singe Tsangpo drainage system but were more restricted to the upstream of the Yarlung Tsangpo west of Xigaze. Investigation of a few short sections of the rivers showed that the hot springs containing very high As should be the main reason which caused the elevated level of As in the river water. In July 2012, water samples (n = 42) were obtained from the drainages of Nujiang River (upstream of the Salween River), Lantsang River (upstream of the Mekong River), Weishan River (upstream of the Red River), Jinsha River (upstream of the Yangtze River), and Danandi River (upstream of the Irrawaddy River) in Yunnan and Tibet. High arsenic concentrations were also observed in hot spring water (range 1.4-894.9 μg/L, average 349.4±356.7 μg/L, median 398.7 μg/L, n = 11). A brine well water at Yanjing beside Lantsang River contained 785.0 μg/L of As. Dug wells water from two villages in Weishan and Jianchuan displayed high arsenic levels too (range 25.7-116.1 μg/L, average 66.4±34.2 μg/L, median 71.7 μg/L, n = 10). However, due to the huge river water dilution and sediment adsorption, arsenic concentrations in these rivers were generally low (range 0.02-75.2 μg/L, average 6.5±16.7 μg/L, median 2.4 μg/L, n = 19) except for the Weishan River (upstream of the Red river) in Yunnan with a maximum [As] of 75.2 μg/L. The localized As enrichments are thus results of input from high arsenic hot springs and low river discharge. The iniatial investigation in July 2013 proved that As enrichment in this area have posed some endemic arseniasis for the local residents in this area.

Analysis of predisposition to neurodegenerative diseases related to the occurrence of potentially harmful metals in the environment

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Abstract Type Poster

Abstract

No more than 10 – 12% of neurologic diseases have a strict genetic aetiology, while the majority of such diseases have an unknown origin. Occupational and environmental exposures to Hg, Al, Mn, Cu, Pb, Fe and Zn appear to be a risk factor for Parkinson's, Alzheimer's and sclerosis' diseases. Therefore, the study of the impact of these environmentally-present metals on human health requires further attention and a multi-disciplinary approach, merging neurosciences and psychology with those more specific to environmental geochemistry. Since the early 1950's, the surroundings of the Estarreja Chemical Complex (NW Portugal) have an intense industrial activity with negative impacts on soils, surface water and groundwater whita population that historically relies on groundwater as a source of water supply for human and agricultural uses. Consequently, this region provides an ideal study area for such multidisciplinary studies. During the 1990's, several rehabilitation actions resulted in an important reduction of the negative environmental legacy. This study combined trace-element profiles in urine and hair with survey information from 100 Estarreja inhabitants to assess the extent to which the biomarkers provide complementary exposure information. We have found contents (µg/L) of Al, Cu, Fe, Hg, Mn, Pb and Zn in groundwater of up to 34900, 2000, 167000, 0.659, 1850, 59.9 and 47100, respectively. These values are well above the international (EPA, WHO) and Portuguese recommended guidelines (Portuguese Law 1998, 2007) for groundwater use. We present the preliminary results of the neuropsychological assessment of participants living in the Estarreja area and analyse the statistical significant differences with the control participants at the level of global cognitive status and cognitive domains. The experimental sample of this study to date has proved to consist mainly of normal subjects, according to the evaluation tests validated for the Portuguese population (40.2%), followed by the condition of dementia (36.6%) and the condition Mild Cognitive Impairment (18.3%). The mean scores of the Geriatric Depression Scale (M = 9.1;6:33) reflect an absence of depressive symptoms in most subjects of the population, while most of the subjects had memory complaints considered relevant to the NDE (M = 3.72, SD = 2.53).The neuropsychological assessment of a pre-selected population in the studied areas is being investigated and compared to the contents of select metals on human biological samples. Urinary metal levels were elevated, above the international guidelines; median urinary values (µg/g creat) for studied elements were: Hg(0.9), Al(21.2), Mn(1.8), Cu(17.0), Pb(2.2), Fe(10.8) and Zn(739.0). Median hair concentrations (µg/g) were also elevated, particularly for Hg: Hg(1.9), Al(4.6), Mn(0.6), Cu(10.2), Pb(0.4), Fe(8.4), and Zn(180.0).No significant association was found between corresponding elements in urine and hair.

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Cancer risk of Santiago Island population due to heavy metal exposure from soils

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Abstract Type Poster

Abstract

Sediments, soils and waters are the vehicles which link the inorganic environment to life through the supplying of essential macro and micro nutrients. The chemical composition of surface geological materials may cause metabolic changes which may favors the occurrence of endemic diseases in humans. Cabral Pinto et al. (2014) presented the Estimated Background Values of some heavy metals of top soils from Santiago Island, Cape Verde. In order to better understand the relationships between environmental geochemistry and public health, it was calculated the average daily dose of a pollutant via soil ingestion, dermal contact and inhalation as exposure pathways, and the lifetime average daily dose was also calculated as a weighted average for each exposure route for carcinogens. We present the Hazard Risk (HI) and Carcinogenic Risk (CR) due to some metal(loid) s exposure of Santiago Island population, according to the Exposure Factors Handbook (USEPA, 1997). The non-carcinogenic hazard index (HI) for all studied metal(loid)s of soils are much smaller than 1, indicating no potential non-carcinogenic risk for adults and children. The HI for As, Cr, Cu, Ni, Pb and Zn to adults and children decrease in the order of Ni > Pb > Cu > As > Cr > Zn. Children HI is larger than adult HI. For cancer risk, the only carcinogen risk for inhalation exposure modes was considered in the model. The level of cancer risk associated with exposure to As, Cr and Ni falls within the range of threshold values of 10^{-9} to 10^{-6} above which environmental and regulatory agencies consider the risk unacceptable (USEPA, 1997).

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Analysis of the main risk factors for lung cancer in Mexico

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Abstract Type Poster

Abstract

In Latin America, Lung Cancer (LC) is the fourth oncologic disease for both genders, having an incidence of 13 cases per 100,000. In Mexico LC is a serious health problem representing the first cause of cancer death in the national statistics (exceeding the mortality for gastric, liver, prostate and breast cancer). The aim of the present study is to analyze the main factors involved in the development of LC in Mexico, including smoking, air pollution represented by particulate matter $PM_{2.5}$ and PM_{10}, and radon exposure. For the analysis, we considered the country distribution of the reported LC deaths occurred from 2001 to 2012. Information of the main risk factors for this neoplasm: smoking, air pollution (mainly particulate matter PM_{10}) and indoor radon exposure were obtained in the same period from national data bases. Descriptive statistics and graphics of each one of the factors were performed. The annual effective dose equivalent (HE) by inhalation of radon (mSv y-1), which correspond to the values of indoor radon concentrations, was calculated according to the methodology of the UNSCEAR- United Nations Scientific Committee on Effects of Atomic Radiation. A stable prevalence of lung cancer deaths (average 6,678 cases per year) during the period studied was found, suggesting a probable effect of the slight reduction of smoking prevalence in adults, as a result of diffusion campaigns and the establishment of anti-tobacco legislation in the country during the last years, that have reduced the number of active and involuntary smokers. Another factor involved could be the lack of medical facilities in rural areas and the lack of a National Registry of Cancer. Using the UNSCEAR methodology, a number 15,187 LC deaths was calculated, far from the official statistics. Therefore probably there is an important under registration of LC cases. According to the information found, exposure to risk factors for LC: smoking, air pollution and radon was high, especially in certain cities of the country which will continue growing since they are poles of industrial development, unfortunately only scarce plans for an adequate urban development exist, therefore megacities continue attracting millions of people looking for employment and a better way of living. A good example is the metropolitan area of Mexico City with around 20 million inhabitants, thousand of factories and millions of cars which is currently one of the most polluted cities in the world. Therefore, actions must be taken to protect the population including lung cancer prevention campaigns, anti-smoking actions and health promotion activities. In natural high ^{222}Rn areas like Chihuahua and Mexico City there should be education campaigns for the inhabitants to minimize ^{222}Rn exposure. Also, it is urgent to increase and improve anti- air pollution programs in the big cities. An accurate National LC Registry is also needed.

Evaluation of the genotoxicity effect and antioxidant response of two nanomaterials ($TiSiO_4$ and nanovesicles of SDS/DDAB) in *Eisenia Andrei*

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Abstract Type Poster

Abstract

The growth of the nanotechnology industry makes more likely the introduction of these materials in the environment. Even though, the number of studies available about the possible toxic effects of nanomaterials (NMS) has increased in the past years, the data is scarce, as a large number of NMs exist. Since soils are extremely important for life, and are easily exposed to the release of these materials, further studies are needed in this compartment. For soil toxicity tests, earthworms are a recommended test species, and have been used with success for more than 30 years. The objective of our work was to determine if different concentrations of two distinct types of NMs, one inorganic (titanium silicon oxide) and other organic (vesicles of sodiumdodecylsulphate/didodecyldimethylammoniumbromide), are genotoxic and also if there is an antioxidant response in terrestrial organisms. To that end, earthworms from the species Eisenia andrei (weight: 300-600 mg) were exposed for 30 days to the artificial OECD soil contaminated with different concentrations of the tested NMs. After the exposure, coelomocytes were extracted from earthworms and DNA damage was measured by comet assay. The activity of antioxidant enzymes (e.g. glutathione peroxidase and glutathione reductase) and lipid peroxidation were also assessed. The results showed that both of the tested NMs are genotoxic, particularly the $TiSiO_4$-NM. Since no statistically significant differences were found in the activity of the tested antioxidant enzymes and in lipid peroxidation, the mechanism of genotoxicity of the tested NMs might not be related with oxidative stress.

Physico-chemical characterization, bioaccessibility and genotoxicity of indoor soil particles

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Abstract Type Poster

Abstract

This project proposes to establish a causal effect between environmental pollution and public health. Young children (<6 years old) are exposed to soil contaminants as a result of hand / object-to-mouth contacts in contaminated outdoor or indoor areas. Soil particles physico-chemical properties influence the dissolution of potentially harmful elements (PHE) and, hence, their bioavailability (fraction of an ingested element which crosses digestive system epitheliums and becomes available for internal distribution) and their bioaccessibility (metal fraction extracted from the solid-phase by gastric (G) and gastrointestinal (GI) fluids). We investigated bioaccessibility and genotoxicologic potencies of oral bioaccessible extracts produced from soil particles collected in Estarreja. Dust were collected in June 2012 inside five houses near the chemical complex of Estarreja, then passed through the sieve to keep only the fraction of soil particles <250 µm. PHE concentrations and bioaccessibility were determined in soil particles and in gastric extracts by ICP-MS. PHE profiles were obtained for the 5 sampling sites, showing differences from site to site for Al, Mn, Cu, Zn, and Pb. The composition of indoor soil particles was related to outdoor contamination and indoor particles production (e.g. cigarette, cooking...). Bioaccessibility testing was carried out using the unified bioaccessibility method (UBM), which mimic the human GI tract. Several studies comparing bioavailability tests in vitro and in vivo have shown that the gastric phase was generally closer to in vivo bioavailability than the intestinal phase. Therefore, in vitro cytotoxic and genotoxic studies were carried out using human gastric cells AGS cell line) exposed to the gastric phase extracted from soil particles. Using the XTT assay, no cytotoxicity was noted at concentrations ranged from 0,53 g/L to 0,067 g/L. Genotoxic potencies were evaluated by the use of the single cell gel electrophoresis (comet assay) and the cytokinesis-block micronucleus assay (CBMN) in combination with the immunolabelling of kinetochore to discriminate centromeric and acentromeric micronuclei. The comet assay highlights DNA primary lesions (strand breaks, abasic site, and oxidative DNA damage). The centromeric CBMN assay detects the structural and numerical chromosomal aberrations and allows to determine aneugenic (chromosome loss) and clastogenic (chromosome breakage) events. For both tests, four concentrations selected to be as closest as possible as real ingested quantity of particles were tested. Using the comet assay dose-dependent responses were observed for the five sites. This increase in primary DNA lesions was greater in three site compared to the two other ones. CBMN assay in ongoing and these results will be helpful to conclude on the relation between dust compositions, bioaccessible PHE and genotoxic potencies.

Environmental exposure to heavy metals in people living near Janghang copper smelter (Korea)

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Abstract Type Poster

Abstract

Introduction: Concentrations of heavy metals exceed safety thresholds in the soil near Janghang Copper Refinery, a smelter in Korea that operated from 1936 to 1989. This study was performed to evaluate level of exposure to heavy metals and potential health effects in people living near the smelter.

Methods: The study included 985 residents aged 30 or more living within 4 km of the smelter and compared them with a control group of people living similar lifestyles in a rural area approximately 15 km from the refinery. The concentrations of selected heavy metals were quantified in blood (Pb, Cd) and urine (Cd, As). For renal damage marker, urinary NAG level was evaluated by ELISA kit.

Results: We compared several metals concentrations according to the distance of residence from the smelter in man without occupational exposure, the mean blood lead concentration was 5.15 μg/dL in residents living <1 km from the smelter, 4.34 μg/dL in those living 1–2 km away, 4.74 μg/dL at 2–3 km, 4.05 μg/dL at 3–4 km, and 3.81 μg/dL in the control area. the mean blood cadmium concentration 2.77 μg/L in residents living <1 km from the smelter, 2.03 μg/L in those living 1–2 km away, 2.34 μg/L at 2–3 km, 1.94 μg/L at 3–4 km away and 1.46 μg/L in residents living in the control area. The urinary Cd showed similar trend by residential distance from smelter with blood Cd. On the other hands, the mean urinary arsenics concentration was 7.69 μg/g creatinine in residents living <1 km from the smelter, 8.32 μg/g creatinine creatinine in those living 1–2 km away, 7.28 μg/g creatinine at 2–3 km, 7.62 μg/g creatinine at 3–4 km away, and 7.52 μg/g creatinine in residents living in the control area, which was not showed clear decreasing pattern with increase of distance from the smelter.

However, after adjusting with age, sex, smoking habit and working history, all of the metals we investigated were higher in individuals living near the smelter and inversely associated with residential distance from it, indicating that it was a key source of heavy metal exposure in this population. Additionally, urinary NAG level showed marginal significantly higher in subjects (5.50±8.56 unit/ g creatinine) living within 4 km from the smelter than those in control area (4.68±4.47 unit/ g creatinine) which showed to associate with urinary Cd level in these population.

Conclusion: Based on these results, we recommend that people who live near a contaminated site should be advised to make efforts to reduce exposure to environmental contaminants and to carefully monitor any health problems possibly related to metal exposure.

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03

Climate change and human health

Curbing climate driven health dangers to human populations: life threatening disease, curable sickness, physical injury

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Abstract Type Oral Presentation

Abstract

There are direct and indirect pathways by which climate change, forced by global warming, impacts human health. Climate change brings increased temperature and rain (moisture) to higher latitudes and higher altitudes that were hostile to insect and animal disease vectors but are now welcoming to them and the disease parasites, viruses, and bacteria they transmit to humans. These include mosquitoes (malaria, dengue fever and other infectious diseases), deer-borne ticks (Lyme disease, encephalitis), rodents (plague, hantavirus), and others. Disease vectors thrive in warmer ecosystems with increased reproduction rate, longer breeding seasons, and quicker parasite maturity. Extreme weather events supported by climate change puts citizens health at risk. Extended heat waves cause heat stroke and kill people, especially the very old and the very young. Thousands died in Europe during 2003 and 2010 heat waves. Extended drought and heat waves can limit water availability, reduce crop yields and kill food animals, putting food security at risk (malnutrition) and fostering dehydration (stomach and intestinal illnesses). Flooding by torrential rains from powerful storms can overwhelm sanitation systems and move pathogens and toxic chemicals over soils into waterways. These can impart infectious diseases such as cholera to densely populated urban centers (seeding epidemics), and contaminate food and water resources. Floods, landslides, high energy tropical storms (hurricanes, typhoons, monsoons) and storm surges in coastal zones put citizens physical health at risk of injury and death. Climate change impacts will be more threatening in the future because global population is projected to grow from 7.3 billion people in 2015 to 9.7 billion in 2050. Most growth will be in urban centers that house 53% (3.8 billion) of the 2015 global population and is forecasted to house 70% (6.8 billion) in 2050, mainly in Africa and Asia. Higher population density increases possible pathogen transmission among people and a potential for epidemics from infectious diseases and diseases from other climate-change bolstered biological and physical hazards. Proven strategies can reduce the number of people exposed to diseases linked to climate change. First is to respect cultural norms when working to educate populations on disease prevention and protection. Second is preparedness: have health clinics/hospitals ready with trained staff, vaccines and medicines to treat diseases; accept international assistance without regard to politics, religion, or ethnicity. Third is to support research on medications that can treat people with contracted diseases and on vaccines that can protect people from disease. For example, a malaria vaccine with promising initial results is in Phase 3 trials. If results are confirmed, the vaccine could save the lives of hundreds of thousands sub-Saharan African children annually. Last is to promptly alert the WHO to disease outbreaks.

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03

Climate change and human health

A trend analysis of greenhouse gas reduction technologies and study on vitalizing national action in response to climate change in Korea

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Abstract Type Poster

Abstract

It is necessary for the government, industry and citizenry to join effort in order to bridge the gap between the greenhouse gas reduction target that the government has set and the actual reduction capacity. We will examine the current status of technologies that are being developed in response to climate change, diagnose their potential and limitations, and propose ways to induce sustainable development of the national climate change response capacity. We will also analyze the activities of the government, industry and civic groups and propose effective ways of vitalizing people's action in response to climate change. We have examined the effect of greenhouse gas on natural ecosystem and its reduction methodology. The scientific basis behind climate change has been summarized and new preventive technologies have been introduced. We anticipate that global warming caused by increasing greenhouse gas CO2 will cause disruption of Earth's ecosystem impacting biological diversity and survival. We hope that this report will provide the policymakers with basic information on greenhouse gas reduction and that it will contribute toward national awareness toward greenhouse gas reduction and global environmental protection. We propose scientific/technological policies related to saving energy and improving efficiency, development of renewable energy, establishing the foundation for climate change response, carbon capture and storage, public relations and education. Expected utilization plans of research results are as follows ; 1) Objective status of greenhouse gas reduction technology, 2) Evaluation of the potential and limitations of technologies in response to climate change, 3) A team of experts centered around the Resource-Environment Special Committee may act as a advisory council and mediate communication between government, industry and citizenry. Public opinion will be gathered and sustainable development for greenhouse gas reduction induced, 4) Seek professional and systematic response through discussion and sharing of technology for greenhouse gas reduction and risk management, 5) Induce interest in climate change and participation in climate change response activities through publication and distribution of a citizen's guide,. Major conclusions and suggestions are that we surveyed the current status of technology tackling climate change, diagnosed problems, and suggestion of more effective greenhouse gas reduction policies, and that we suggested policies for government, industry and citizenry to vitalize n national climate change response action.

Richness and diversity in dust stormborne biomes at the Southeast Mediterranean

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Abstract Type Poster

Abstrac

Dust storms include particulate matter that is transported over land and sea with biota that could impact downwind ecosystems. In addition to the physico-chemical compositions, organismal diversities of dust from two storm events in southern Israel, December 2012 (Ev12) and January 2013 (Ev13), were determined by pyro-sequencing using primers universal to 16S and 18S rRNA genes and compared. The bio-assemblages in the collected dust samples were affiliated with scores of different taxa. Distinct patterns of richness and diversity of the two events were influenced by the origins of the air masses: Ev13 was rich with reads affiliated to Betaproteobacteria and Embryophyta, consistent with a European origin. Ev12, originated in north-Africa, contained significantly more of the Actinobacteria and fungi, without conifers. The abundance of bacterial and eukaryotic reads demonstrates dissemination of biological material in dust that may impose health hazards of pathogens and allergens, and influence vegetation migration throughout the world.

Impact of climate change on human health in African coastal cities: case study from Durban, KwaZulu Natal (KZN) Province (South Africa)

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Abstract Type Poster

Abstrac

It is now established that all coastal locations are at risk to the impacts of climate change, accelerated sea-level rise and other coastal implications of rising global temperatures such as changing storm frequencies. Climate change is caused by emissions of greenhouse gases, largely from energy production and consumption, agriculture and other ecological processes. The impacts of climate change are likely to worsen many problems that coastal areas already face - shoreline erosion, coastal flooding and water pollution. But, according to the Lancet, changing climate and its impact on health is the most serious health threat of the 21st century. The purpose of this review is to examine the effects of global warming on human health in the City of Durban in South Africa as a case study, so as to be able to put forward interventions for mitigating the impacts and evolve tangible coping strategies for African coastal cities. Durban is the largest City in the Province of KwaZulu-Natal in South Africa. It is the nation's principal seaport and the second largest manufacturing hub in South Africa after Johannesburg. It is also seen as one of the major centres of tourism because of the city's warm subtropical climate and extensive beaches. The projected increase in the rate of climate change in Durban will continue to threaten human health and well being. The latest report from the Intergovernmental Panel on Climate Change (IPCC) identifies various climate change-related health impacts, including altered distribution of some infectious diseases and disease vectors. According to the report, projected trends in climate change-related exposures will increase malnutrition and consequent disorders; increase the number of people suffering from death, disease and injury from heat waves, floods, storms, fires and droughts; and will continue to change the range of some infectious disease vectors. Respiratory diseases, skin cancer, immunosuppression, heat stroke, gastrointestinal diseases, vector-borne diseases and occupational related diseases have all been showing distinct patterns of occurrence as well as increasing frequency in Durban ever since the debate on global warming came began in the twentieth century. Our studies show that those that are at greatest risk from the effects of climate change in Durban are the urban poor, the elderly, children, traditional societies and subsistence farmers. Addressing the additional stress of climate change on human health may require new approaches to managing land, water, waste, and ecosystems. More research on climate change and health is needed, as well as improved access to research data. Extensive health education on climate change and global warming to the public are prerequisites for preserving the environmental integrity of this coastal City. This will require dedicated multi-sectoral and intergovernmental collaboration and coordination.

The effect of dust storm events on daily outpatient visits for respiratory diseases in Kinmen (Taiwan)

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Abstract Type Poster

Abstrac

Dust storms originating from the arid deserts of Mongolia and China are typical extreme climate events in the last two decades and affect air quality in the neighboring countries, such as Taiwan, Korea and Japan. However, the studies on adverse health effects of dust storms which are defined as horizontal visibility is less than 1 km are limited. The purpose of this study aims to discuss the effects of 17 dust storm events during the period from 2005 to 2010 in Kinmen County, an isolate island near China mainland.From the random sample of one million people in the National Health Insurance Research Database (NHIRD) of Taiwan, we retrieved records on outpatient visits for respiratory diseases (ICD-9 codes 460 to 510) in Kinmen County from 2005 to 2010. We obtain daily data on PM_{10}, $PM_{2.5}$, carbon monoxide (CO), ozone (O_3), nitrogen oxide (NO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) from the air quality monitoring stations established in Kinmen County by the Environmental Protection Administration. The case-crossover design is used to evaluate and describe the effects of dust storm events on outpatient visits for respiratory diseases and referent days were selected on the same day of week and within the same calendar month as the outpatient visit of interest next year. Finally, we further to establish a Poisson regression model of outpatient visits and air pollutants. In 17 dust storm events from 2005 to 2010, 761 outpatient visits for respiration diseases were identified in the study population.We found out that the concentration of air pollutants, such as O_3, NO, NO_2 and PM_{10}, were higher in the dust storm events than 3 days before the occurrence of dust storm events. For example, the average PM_{10} in the dust storm events higher than the average for the comparison days. To compare with the referent days next year, the clinical visits of respiration diseases are higher in the dust storm events than in the referent group. The relative risk (RR) between air pollutants and respiration diseases visits in 17 dust storm events is estimated 1.0154 (95% CI, 1.0007, 1.0304) for NO_2 and 1.0008 (95% CI, 1.0004, 1.0012) for PM_{10}. Further analyses on data from other years and lagged effects of air pollutants are underway. This study provides evidence supporting effect of NO_2 and PM_{10} on outpatient visits for respiration diseases.

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04

Therapeutic properties of minerals and waters

Magnesium-rich evaporites from Lake Chad Basin used as medicine

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Abstract Type Oral Presentation

Abstract

Evaporites occur in abundance in parts of North-eastern Nigeria and Niger Republic around the Lake Chad Basin where they are mined and marketed by villagers. Traditional medical practitioners in this region claimed that the salts are effective for management of gastrointestinal tract (GIT) problems, treatment of ulcers, skin diseases, and traditional postnatal activities. They are also used for ethno-veterinary practices as component of livestock feeds/medicine. Samples (15) of the salts were subjected to acute toxicity studies on Wistar rats with the view to establish their safety or otherwise on the animals. The results revealed that 6 out of the 15 samples exhibited oral medium lethal doses (LD_{50}) above 5000 mg/kg. Analysis of the salts samples using atomic absorption spectrometry (AAS) shows relatively high magnesium content of 789 to 19219 mg/kg. Although magnesium is an essential mineral for optimal metabolic function and it is found to be relatively safe in some of these salts at appropriate dosages, magnesium may cause adverse effects or death at high dosages.

Edible and healing clays: benefits and risks

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Abstract Type Oral Presentation

Abstract

Clay, a common geomaterial, has been used by humans since before recorded history to accomplish basic but fundamental health care purposes. There are several types of clay, and within them the so-called edible clay and healing clay have been used by man for therapeutic, nutritional and cosmetic purposes. The use of edible clay is limited to internal application through ingestion, under the form of cookies made of clay/animal fat or of clay/potable water suspension. Conceptually healing clay besides internal application can be used in external or topical application under the form of clay/mineral water paste called mud or peloid. Clay minerals which are hydrous phyllosilicates of very small particle size and as a rule platy shape, are the fundamental clay constituents characterized by particular crystallochemical properties, the unique globally negative electric charge being the most important one, since it is responsible for the reversible fixation or adsorption of chemical elements and polar compounds. With regard to clay/human body interaction, clay particles could adsorb and make available for incorporation through ingestion, either bioessential or toxic elements (e.g. heavy metals); also they could adsorb and make available for elimination or excretion any potential toxic elements or toxins being ingested or produced. This presentation endeavours to show the benefits and risks of using edible and healing clays for health and skin care. In what edible clay is concerned it is particularly reckoned as a potential means for: dietary supplementation of the mineral nutrients necessary for the synthesis of new tissues; combating iron deficiency or anaemia; detoxification of noxious or unpalatable compounds present in the diet and relief of abdominal pains (heartburn) with accompanying vomiting. Constipation as well as reduction of the adsorption capacity of elements or compounds (existing for instance in drugs almost simultaneously taken with the clay) could be risks for edible clay or healing clay ingestion. In what the external use of healing clay is concerned, the clay/mineral water paste could be applied directly onto the skin, as mud or peloid pack and as facial mask, for instance in joints, backbone and facial regions. Just before its application mud or peloid could be heated up to about 45°C. Mudtherapy and pelotherapy are reckoned as being potential efficient means to treat muscular-skeletal affections due to a double process: thermotherapy and chemotherapy. Mud and peloid are particularly distinguished because mud is maturated in a natural environment, whereas peloid is maturated in an artificial environment. Microbiological control, particularly of pathogenic microorganisms, is essential along the processes of preparation, storage and application of both mud and peloid.

Portugal: one of Europe's richest countries ... in mineral and thermal waters

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Abstract Type Oral Presentation

Abstract

In Portugal Spas are undergone a considerable development, not only in the "Classic Hydrotherapy" but also in the sense of "Thermal Wellness". In general Spas (and Portugal is no exception) are located in natural environments of excellence which, associated with thermal structures (hotels facilities included), equipment and available technologies at the Spa Resorts, provide excellent conditions to recover "the body and the soul" of the stress accumulated from modern living.

Among groundwaters, mineral and thermal waters are the "noblest relative" since they originate from atmospheric precipitation which infiltrates underground via deep crustal discontinuities (major faults), retaining particular physical and chemical characteristics according to the mineralogical composition of the geological formations through which they flow and interact. Also, their emergence temperature is a function of the depth at which these waters have been circulating. Since thermal waters come into contact with rock at higher temperatures, their total mineralization is, in most of the cases, greater than in mineral waters. The combination of these properties enables us to face the Hydrotherapy as a vehicle of social and economic development of both the localities and regions where Spas are located. In many cases it is even a major, if not the main, source of local/regional development. In a near future, many of the Spa Resorts could be confronted with the need for a greater demand for mineral and thermal water, since the one coming of the current sources could not be enough to cover the growing number of Spa users. This work seeks to highlight the role that the assessment of a hydrogeological conceptual circulation model of the mineral and thermal waters of a given region has in drilling plans (in order to capture mineral and thermal waters with higher flow rate and / or temperature) and development (use of thermal water in its various forms). To this end, a multi- and interdisciplinary approach, from various disciplines (Geosciences domain) such as Geology, Geochemistry, Hydrogeology and Geophysics, is crucial.

Novel therapeutic indications – the mineral water of Termas de Águas Spa (Penamacor, Portugal)

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Abstract Type Oral Presentation

Abstract

Thermal mineral waters are a potential resource in the economic development of a region. The thermal Águas Spa is located in the inner region of central Portugal and its grant will enable the exploration and exploitation of this water resource for medical and therapeutic purposes through a thermal medical spa. The study area is located in the Central Iberian Zone, central Portugal, at the village of Águas, about 42 km NE of Castelo Branco and 5 km south of Penamacor. The main idea of this research is to establish the principal water characteristics that allowed its recognition, by the Portuguese Ministry of Health, for rheumatic and respiratory diseases treatment. Termas de Águas Spa has a current use groundwater catchment located in the granitic pluton of Penamacor-Monsanto, which intruded the schist-metagraywacke complex. Topically, there are dispersed alluvial materials from the Ribeira das Termas; the main river through the survey area. This thermal mineral water aquifer is located in a slightly altered granite, highly fractured, corresponding to a semi-confined – confined aquifer, with superficial runoff groundwater recharge. The groundwater catchment (AM4), about 328 m deep, holds an average flow of 0.8 L/s. The main features of the mineralized water are: temperature of 19ºC, neutral pH (pH = 7.3), low mineralization (total mineralization = 244 mg/L), sulphurous (H_2S = 0.31 mg/L), sodium and bicarbonate type (HCO_3^- = 128 mg/L, Na = 56.4 mg/L), slightly fluoride (F^- = 2.5 mg/L) and substantial amounts of silica (SiO_2 = 35.8 mg/L), corresponding to 15% of the total mineralization. A physico-chemical comparison between the groundwater of the catchment AM4, and similar waters, corresponding to the main Portuguese thermal units, shows a lower pH (pH range = 8.3-9.5) and a lower fluoride content (global average of F = 9.9-24.0 mg/L). These features may introduce novel utilities concerning to hydrotherapy, particularly in the treatment of rheumatic and respiratory diseases.

Lithium in drinking water and suicide: a Danish nationwide register-based cohort study using spatial analysis

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Abstract Type Oral Presentation

Abstract

Introduction: Lithium occurs naturally in drinking water and may have a positive effect on mental health and suicide. In clinical practice, lithium in high therapeutic doses is used as a mood-stabilizer in the treatment of affective disorders. Previous studies performed at an ecological level have found an association between lithium in drinking water and risk of suicide.

Aims: The present study examined the geographical distribution of lithium in Denmark and investigated whether long-term exposure to naturally occurring low levels of lithium in drinking water was associated with a reduced risk of suicide at an individual level.

Methods: The study population consisted of all 3,671,546 Danish adults (≥20 years) of which 12,613 committed suicide between 1990-2006. Information on suicides was obtained from the nationwide Danish Register of Causes of Death. Data on lithium concentrations were obtained through a nationwide drinking water campaign from 2013 including 151 measurements from waterworks supplying approximately 42% of all residents in Denmark. The measurements were interpolated using point kriging and an accumulated lithium exposure was computed for each individual based on municipality of residence every year. Spatial statistics were applied to investigate geographical patterns in lithium levels. Poisson regression analyses were used to investigate the association between accumulated lithium exposure and suicide rate.

Results: Significant regional clustering in drinking water lithium levels were found with high levels in Eastern and low levels in Western Denmark. The regression analyses showed a significant dose-response trend of decreasing suicide rates with increasing accumulated lithium exposure. The trend remained after adjustment for gender, age, socioeconomic status, civil status, and calendar year.

Conclusions: The findings support the growing evidence of long-term exposure to naturally occurring lithium levels being protective against suicide. If these findings can be further supported they may have implications for individuals at high risk of committing suicide.

MEDGEO'15

poster

6th International
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04

Therapeutic properties of minerals and waters

Plasticity of different smectitic admixtures intended for health care purposes

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Abstract Type Poster

Abstract

Nowadays, clays and clay minerals are used in many pharmaceutic, therapeutic and cosmetic formulations, due to their unique characteristics and properties widely reported in the literature. This study aim, mainly, to assess the influence of the addition of several supplements to a Portuguese smectitic sample on the plasticity of the final product in order to be used topically for health care purposes. The supplements studied included glycerine, hydrogel, saturation in calcium and kaolin.

Mineralogical analysis were carried out by X-Ray diffraction, in random-oriented powders (fraction <63 µm) and in oriented aggregates (<2µm). The semi-quantification of the main minerals identified, peak areas of the specific reflections were assessed using MacDiff v 4.2.5 and calculated according to their specific intensity factors. Smectitic sample show high content on phyllosilicates (63%), calcite (20%), anatase (11%) and minor content (<3%) of quartz, feldspar, iron-minerals and dolomite. The mineral phase used as additive, the kaolinitic sample, contributed mainly with its characteristic clay mineral. SEM-EDS allowed the determination of structural formula of the smectites before and after the mixture with the additives.

Chemical composition was assessed by X-Ray fluorescence and provided the data for major chemical elements: SiO_2, Al_2O_3, Fe_2O_3, TiO_2, MnO, CaO, MgO, K_2O, Na_2O, P_2O_5 and Loss-on-Ignition. Trace elements considered potentially toxic such as: As, Sb, Cd, Co, Cu, Pb, Ni, Zn, Se, Te, Tl, and Ba were also analysed.

Liquid limit was assessed using Fall cone test (fulfilling the ISO/TS 17892-6 indications). The plastic limit determination followed the procedure recommended by ASTM D4318-10 and the plasticity index was calculated, according to the same standard, as the difference between the liquid limit and the plastic limit. Smectitic sample is considered highly plastic (liquid limit = 76%). The effect of the several additives on plasticity reveals that kaolin and glycerin supplements decreases plasticity. The highest improvement in the plasticity was achieved with hydrogel addition particularly with the formulation hydrogel plus calcium saturation.

The results suggested that smectitic clay plasticity is influenced by the type of supplement added, being the hydrogel the most interesting if an higher plasticity is requested.

Bioaccessibility of trace elements in clayey commercial nutritional supplements

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Abstract Type Poster

Abstract

Clay minerals are used for a wide range of applications namely in health care products due to their versatility, biocompatibility, and biological activity. The present study analyse eight clayey commercial samples appointed to ingestion for nutritional and health care purposes. Intending to increase the knowledge about these type of products, this study aims: (i) the identification and semi-quantification of the main clay mineral(s) present in the nutritional supplements studied, and (ii) the determination of the bioaccessible fraction of some trace elements and main exchangeable cations of clay minerals in the samples for both the gastric and gastrointestinal phases using the Unified BARGE method. Mineralogical analysis of both fine and clay fractions were carried out by X-Ray diffraction, in random-oriented powders (total sample) and in oriented aggregates (<2 μm). According to the results, samples present a polimineral composition with variable content of phyllosilicates (illite, smectite, kaolinite and/or vermiculite) and other phases such as quartz, carbonates (calcite and/or dolomite) and feldspars that in some cases are present in relevant amounts. Chemical composition was assessed by X-Ray fluorescence and provided the data for major chemical elements: SiO_2, Al_2O_3, Fe^2O_3, TiO_2, MnO, CaO, MgO, K_2O, Na_2O, P_2O_5 and Loss-on-Ignition. Trace elements concentrations considered potentially toxic such as: As, Sb, Cd, Co, Cu, Pb, Ni, Zn, Se, Te, Tl, and Ba were also analysed. Total concentrations of Al, As, Ca, Cu, Cr, Fe, Hg, K, Mg, Mn, Mo, Pb, Se, Si and Zn were determined by ICP and the in-vitro gastrointestinal extraction, known as oral bioaccessibility, was assessed using the Unified BARGE method. The total digest, gastric phase and gastro-intestinal phase concentrations of those elements were determined by ICP.

Rheological properties of water suspensions of a pharmaceutical grade smectite

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Abstract Type Poster

Abstract

Clays are used in wide range of pharmaceutical and cosmetic applications, as active ingredients or excipients. In particular, they are presented in many semisolid dosage forms with different functions, including stabilization of suspensions and emulsions. Semisolid dosage forms are topical products intended for application on the skin, so they must present suitable properties for this purpose (they require a consistency suitable for application, and enough viscosity to remain in contact with the application area). The physical properties of these dosage forms depend upon various factors, including the size of the dispersed particles, the interfacial tension between the phases and the rheology. Rheological properties of semisolid pharmaceutical products greatly determine their physical stability and applications. Many authors have been studied rheological properties of different clay suspensions, but there are few articles about the influence of preparation conditions on the rheological behavior of concentrated clay/water systems. Concentrated clay suspensions resulting in structured gels. Clay gelling structures come from the aggregation of clay minerals particles by different mechanisms mainly depending on the type of clay minerals dispersed, pH and ionic strength. Rheological properties obviously depend on the characteristics of the particles and their aggregation, but also on other factors such as preparation conditions (mixing energy, type of mixer used, mixing time), temperature and presence of other components in the formulation.

With these premises, aim of this work was to study the influence of preparation conditions on rheological properties of clay-water suspensions prepared with Veegum® F (pharmaceutical grade clay). Suspensions were made at three different concentrations (10, 15 and 25% w/w) using a turbine stirrer, working during 5 minutes at three different mixing rates (2000, 4000 and 8000 rpm). Rheological measurements were taken immediately after interposition and allowed to swell for 48 hours, using a Controlled Rate Viscometer. Measurements were carried out at 25ºC and in the shear rate range 10-800 s. Apparent viscosity values were obtained from flow curves. The systems showed typical non-Newtonian viscoplastic flow curves with thixotropy. Apparent viscosity and thixotropy increased with increasing solid concentration, mixing energy and time.

Studies of freshwater sediments (gyttja): analysis of composition and chemical properties

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Abstract Type Poster

Abstract

Specific sediments of mud consistency can be found in many estuaries; among them, freshwater sediments with high organic matter content are identified as gyttja (also called as sapropel or dy). Such sediments belong to unique geological formation and predominantly consist of organic remains (e.g., shell detritus, plankton, chitin of insects, remains and spores of higher plants) in mixture with minerals washed out from the waterbed basin. Gyttja formation is common under the environmental conditions of eutrophic waterbeds that are shallow, overgrown or overgrowing post-glacial lakes or valleys of big rivers with slow stream located in boreal zone of the world. Freshwater sediments can be classified taking into account the ratio of mineral part and organic matter content; thus biogenic, clastic and mixed are the three main classes of gyttja. Subdividing classes, the type of gyttja can be identified, e.g., cyanobacteria, green algae, carbonatic, organic-sandy and diatoms type of gyttja. In overall, gyttja can be described as plastic natural material of gel-like consistency with fine and disperse structure, with colour usually from dark blue (due to high content of phosphorus) to dark green which after drying becomes light blue to grey-brown, depending on composition. Studies of gyttja in Latvia (north-east of Europe) currently are intensified due to its huge resources extractable from the lakes of the country, with the aim to expand the practical use of these freshwater sediments. Gyttja is one of the highly valuable natural resources, similarly like peat, that can be extracted up to 500 million tons from freshwater lakes in Latvia. Many cores of samples from several potentially sediment rich lakes have been derived and analysed layer by layer to detect the chemical properties of gyttja. The main directions of studies are related to the research of biological active substances, including proteins and enzymes, as well as investigation of interactions between the organic and mineral parts of gyttja. Analysis of chemical properties involved detection of such parameters as pH, oxidation-reduction potential, free radical activity, organic chemical composition and quantitative content of trace and major elements in gyttja. Obtained results of organic analysis revealed that gyttja contain lipids (bitumen), hydrolyzed water-soluble substances (humic and fulvic acids), cellulose and non-hydrolysable residual part. Inorganic analysis showed that gyttja contain high amount of various major elements and trace elements, including potentially toxic chemical elements. The economic value of gyttja increase by the content of organic matter; currently this natural material is used for soil applications in agriculture, horticulture and forestry.

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The magic (?) ion in Portuguese drinking water: preliminary results

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Abstract Type Poster

Abstract

Lithium is the gold standard treatment for several mental disorders. Although lithium is considered toxic (in high amounts), there are growing evidences from ecological studies which supports the hypothesis that the intake of natural levels of lithium in drinking water might have a protecting effect on the risk either of suicide or even in violent crimes. However, its physiological role is not clear. This study reports the first results on lithium concentrations in sampled tap (from 49 Municipalities) and purchased bottled (24 brands) Portuguese waters from the whole country (continent and islands). Its content is unknown as the element is not a legislated quality parameter for human consumption, The Portuguese tap waters analysed present lower lithium concentrations (max. 190 µg/L) than bottled waters (max. 2210 µg/L) which reflect that lithium concentrations in waters are depending on hydrogeological features, such as geological environment at the recharge area, underground flow paths, depth (and temperature) of water-rock interaction, possible mixing of different groundwater systems, etc.. Although suicide and violent crimes are complex phenomena with many variables, their statistical relationship with lithium levels in our analysed tap water samples (by ICP-MS at Actlabs, Canada) will be presented and discussed. Future research with more data as the lithium content in drinking waters from all Portuguese Municipalities and clinical trials are ongoing and planned. This research is important considering possible benefits to the population health.

Potentially toxic elements distribution in marine sediments (peloids), water and biota of Makirina bay (N Dalmatia, Republic of Croatia)

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Abstract Type Poster

Abstract

Makirina Bay (N Dalmatia, Republic of Croatia) represents one of the major and most important sites where organic-rich sediments accumulates along Eastern Adriatic coast. These sediments, according to their organoleptic properties, are suitable to be applied as a raw material for different therapeutic, cosmetic, and wellness-related purposes. In addition, Makirina Bay peloid mud is already frequently used by local people and tourists as pomades. Peloid mud is collected in-situ from the bay, applied directly on the skin, and sun dried. In order to estimate the quality of Makirina bay, samples of surficial peloids (0-5 cm), water and biota (gastropoda Monodonta turbinata, shore crab Carcinus mediterraneous, seagrass Cymodocea nodosa and sea algae Codium bursa) were collected to anayse quantitatively for the presence of several potentially toxic elements (As, Cd, Cu, Mo, Ni, Pb and Zn). In additional the transfer factor (TF) was calculated to assess mobilities of potentially toxic elements by aquatic organisms. Potentially toxic elements (PTE) concentration in surficial peloids are: As (14.47 mg/kg), Cd (0.27 mg/kg), Cu (27.64 mg/kg), Mo (13.82 mg/kg), Ni (26.51 mg/kg), Pb (23.74 mg/kg) and Zn (47.67 mg/kg). PTE, determined in water are: As (1.5 µg/L), Cd (0.17 µg/L), Cu (9.6 µg/L), Mo (14.2 µg/L), Ni (59 µg/L), Pb (0.1 µg/L) and Zn (14.8 µg/L). The order of average PTE concentrations (from lower to higher ones) in gastropoda Monodonta turbinata is: Cd < Pb < Mo < Ni < As < Cu < Zn, in shore crab Carcinus mediterraneous: Cd < Mo < Pb < Ni < Zn < As < Cu, in seagrass Cymodocea nodosa: Cd < As < Mo < Pb < Ni < Cu < Zn and in sea algae Codium bursa: Cd < Mo < Pb < As < Cu < Ni < Zn. It can be obtained that Cu and Zn are PTE that occur in all media at the highest concentrations while Cd at lowest concentrations. The calculated TF from surficial peloids in relation to aquatic organisms showed that Cymodocea nodosa and Codium bursa does not accumulate PTE (TF < 1 for all PTE), whereas Carcinus mediterraneous accumulate As (TF = 3.6), Cu (TF = 3.1) and Zn (TF = 1) and Monodonta turbinata As (TF = 1.5) and Cu (TF = 1.3). However concentrations of Zn in peloids does not exceed EC-TEL (Environment Canada – Threshold effect level) meaning that adverse effects to organisms rarely occurs, while concentrations of As and Cu are bellow EC-PEL (Environment Canada – Probable effect level) meaning that adverse effects can occur occassionally. Cu and Zn are classified as essential PTE for all organisms, but at high levels they can be toxic and cause several side effects to organisms, including human, meanwhile As has no biological function and is toxic even in trace amounts. Aforementioned PTE require special consideration, therefore additional researches of Makirina bay are necessary in the future.

Molecular simulations of intercalated LDH and Layered Zinc Hydroxide Salts with organic species for possible medical applications

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Abstract Type Poster

Abstract

Methods of molecular simulations were used for structure analysis of various intercalated layered structures like layer double hydroxides (LDH) with different porphyrin anions or paracetamol and Layered Zinc Hydroxide Salts with Dodecyl Sulfate Anions. Presented calculated models are in a good agreement with experimental data. We obtain detail description of mutual interactions, energies, charge distribution etc. Intercalation of 5, 10, 15, 20-tetrakis (4-sulfonatophenyl) porphyrins (TPPS) into ZnRAl and MgRAl LDH hosts led to a gallery height of about 15.5A°. The porphyrin sulfonate groups are located at about 4 A° from the center of the hydroxide layers. The aromatic ring system in the middle of the gallery is rather disordered. Molecular dynamics simulations show that the interlayer space is filled with nearly parallel porphyrin units with a slightly inclined slope orientation of the porphyrin planes with respect to the normal of the hydroxide layers. The photophysical experi-ments proved that TPPS in Mg_2Al LDH hosts produce O_2 ($1\Delta g$) with long effective lifetimes. Singlet oxygen is a highly reactive oxidation agent and it is generally accepted that $^1O_2$ [mostly $O_2(1\Delta g)$] is the main cytotoxic species in photodynamic therapy of cancer [1]. The product intercalated with the nonionic, water-soluble pharmaceuticals paracetamol, N-(4-hydroxyphenyl) acetamide, was prepared by rehydration of the Mg–Al mixed oxide obtained by calcination of hydrotalcite-like precursor at 500°C. Simulations showed that the phenolic hydroxyl groups of paracetamol interact with hydroxide sheets of the host via the hydroxyl groups of the positively charged sites of Al-containing octahedra. Dissolution tests in various media showed slower release of paracetamol intercalated in the hydrotalcite-like host in comparison with tablets containing the powdered pharmaceuticals [2]. Structural arrangements of dodecyl sulfate (DS) anions, widely used in many branches of human life, were investgated in the interlayer space of layered zinc hydroxide salts (LZH-DS). As-prepared, well-crystalline LZH-DS has a basal spacing of 31.5 Å. After treatment with methanol at room temperature, zinc hydroxide layers shrank to form two new layered phases with basal spacings of 26.4 and 24.7 Å. The interlayer space of all three phases was modeled by molecular dynamics, and the models were validated with experimental data. Higher temperature at 55°C leads to the formation of a second-staging heterostructure with the regular alternation of layers with two basal spacings, 31.5 and 34.2 Å. This is the first reported interstratification phenomenon in layered hydroxides intercalated with aliphatic molecules [3].

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Impact of micro- and macroelement content on potential use of freshwater sediments (gyttja) derived from lakes of Latvia

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Abstract Type Poster

Abstract

In many fresh and salty water bodies worldwide environmental conditions are appropriate for sediment formation; the Dead Sea mud can be mentioned among the best known sediments with practical use. Gyttja (sapropel or dy) are freshwater sediments formed from the remains of water plants, plankton and benthic organisms which are transformed by microorganisms, and mixed with mineral components supplied from the lake basin. Analysis of chemical element content and concentration in gyttja not only play important role in the reconstruction process of evaluation of water body ecosystems over the time, but also allow deeper geochemical research of sediment layers with the aim to detect natural geochemical background, as well as to identify the intensity of anthropogenic impact. It is characteristics that gyttja contain high amount of organic matter and, as metallic elements are tended to be incorporated in complexes with organic substances, it is important to study presence and concentration of elements, especially, regarding potentially toxic elements (such as As, Cd, Cr, Pb) in samples of sediments. Furthermore, element analysis is significant step in the risk assessment of practical use of gyttja. The study involved analysis of freshwater sediments derived from five lakes in Latvia (the Pilvelis, the Veveris, the Padelis, the Driksnas and the Pilcines Lake). Depending on sample composition it was possible to determine the type of gyttja; thus samples were identified as peaty, cyanobacteria, green algae, carbonatic, diatoms and organic-sandy types of gyttja. Dried samples were wet digested using concentrated nitric acid and hydrogen peroxide was applied by heating until complete sample mineralization. Sample solutions were analysed by atomic absorption spectrometry (AAS) to detect macroelements (Ca, Fe, K, Mg, Mn, Na, Zn) and by inductively coupled plasma mass spectrometry (ICP-MS) for microelement (As, Ba, Cd, Co, Cr, Cu, Li, Ni, Pb, Rb, Se, Sr and V) concentration measurements. Preliminary results indicated that higher macroelement concentration was found in carbonatic gyttja, while the lowest in cyanobacteria gyttja. But higher microelement concentration was detected for organic-sandy gyttja. Total content of elements was variable and dependent on the conditions of water body basin where gyttja samples were derived. Regarding high organic matter content gyttja practically is used in agriculture, horticulture and forestry where these sediments can be applied to soil as natural fertilizer. However, there is a potential to use this natural material in chemical industry, medicine and cosmetology, but these spheres are highly interested in the safety and purity of materials and products.

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Medical and balneological assessment of groundwaters in Ukraine: optimization of groundwater use

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Abstract Type Poster

Abstract

In Ukraine, like in any other country, groundwater is a strategic resource that determines the health of population. Its significance and value will only increase through time. The need to enlarge groundwater usage for Ukraine is particularly important because over 70% of Ukrainian population (about 30 million) consume surface water from the Dnieper basin, condition of which is unsatisfactory. According to the Ukrainian legislation, groundwater is a mineral product, reserves of which are estimated, calculated and is to be accounted. Groundwater properties, which are conditioned primarily by geological factors, determine their suitability in order to meet the drinking needs under unsystematic consumption, and are used for therapeutic purposes under systematic consumption. The aim of our research is to establish and evaluate regional and local aspects on how groundwater chemical composition affects population health in Ukraine, in order to optimize the drinking water supply system. Thus, the following aspects were examined: the state of groundwater resources in Ukraine, typification of the territory in terms of geological formations conditions, hydrogeochemical and hydrogeodynamical conditions of groundwater resources, medical and balneological assessment of groundwaters quality. Among the problems of groundwater supply in Ukraine, a separate issue is to minimize the human influence on groundwater, the positive and negative effects of groundwater on life conditions. A strategy for geological study and use of drinking groundwater resources was developed for water supply of Ukrainian population. It outlines the assessment and usage of groundwaters for water supply within the cities and urban-industrial agglomerations.

Practices of mudtherapy in Porto de Mós' beach, Algarve (Portugal)

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Abstract Type Poster

Abstract

Gomes et al. (2013) did propose the designations mud therapy or mudtherapy and peloid therapy or pelotherapy to the therapeutic use of natural peloids and of manipulated or artificial peloids, respectively. In Portugal there is a long tradition of mudtherapy practices all carried out in sites located in beaches of the Atlantic coast, such as Praia da Consolação, Praia da Parede, Praia do Meco, and Praia de Porto de Mós. In all cases, and on an empiric way, people use mud for therapeutic and cosmetic purposes. Also, in all sites referred to the mud is classified as marly clay and, is mainly applied as facial masks or as packs directly covering joint areas (particularly knee, elbow and hand joints). After application mud remains adhered onto the skin until it gets fully dried through exposure to sunshine. Afterwards mud is washed out with seawater or taking a sea-bath. In Porto de Mós' beach the marly clay dated of Aptian occurs at the base of a low cliff and is everyday seawater washed at high tides. The relevant properties of the marly clay such as, grain size distribution, specific surface area, cation exchange capacity, exchangeable cations, mineralogical and chemical composition (trace elements included) have been studied in order to find out the scientific justifications for its traditionally recognized health benefits. The liquid phase of the natural peloid locally used for healing purposes is the saline electrolyte that results from the interaction marly clay/seawater. The analyses were carried out, both in the size fraction less than 0.063 mm of the natural mud, and in the same size fraction of the mud washed up with demineralized water, in order to remove the saline electrolyte. Natural peloids are 3-phase natural materials. However, as a rule, the solid phase (either inorganic or organic) is the most studied. Gomes et al. (2014) emphasize the decisive role of the liquid phase, both in natural and artificial peloids. The natural peloid of Porto de Mós' beach is a naturally maturated mixture of marly clay and seawater, clay being mainly the support and seawater being the carrier and supplier of the biochemically active principles.

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05

Urban medical geology

Assessment of the potential bioavailability of metals by sequential extraction in urban road-deposited sediment of a small urban area: Vila Real, NE Portugal

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Abstract Type Oral presentation

Abstract

The composition of road-deposited sediment (RDS) reflects the inputs from a variety of sources in urban environments. Road sediments have been identified as the primary source of urban nonpoint pollutants entering the receiving waters and as having a major potential impact on human health. To assess sediment-associated metals, sequential extraction procedures are commonly applied and used as a measure of their potential mobility and bioavailability to living organisms. This study presents the results on the evaluation of the geochemical association of selected metals in road-deposited sediments (RDS) of Vila Real city (Northern Portugal), located in the northeast Portugal, in the Trás-os-Montes region, in an upland surrounded by mountains. It is a small urban area with 52,781 inhabitants. A set of 22 road deposited sediment samples were collected in urban and periurban areas as well as in public playgrounds and in the industrial area. The <1mm fraction of finer particulate material was separated and subjected to chemical analysis. To assess the bioavailability of As, Cd, Co, Cr, Cu, Ni, Pb, Zn, Fe, Mn, the modified BCR sequential extraction procedure was used. The residual fraction was decomposed with aqua regia. The elemental concentrations were obtained by ICP-AES. Replicates and reference material were included in the analytical sequence to ensure accuracy and repeatability. Recovery ranged from 87% to 99%. The precision of the measurements is about ±5%. Total contents of As, Cr, Cu, Fe, Mn, Ni, Pb, Zn and V indicate relative enrichments in samples collected in the main streets and roads, showing spatial variability. Higher contents of Zn, Cu, Pb and Ni were found. Cadmium and Co concentrations were below the detection limit (1.5 µg/g and 3.2 µg/g, respectively). The association of Cu, Pb and Zn is observed in samples collected in the streets with high traffic density and industrial activity; in general, higher relative amounts of Fe and Mn are also found in these samples. Associations between V, Cr, Ni, Fe and Mn are found in samples collected near garden areas and in green parks. The sequential extraction analysis shows significant contents of Zn associates in the exchangeable fraction, in particular in samples showing the higher total contents. Nickel also reveals relative higher contents in the exchangeable form in the samples collected in the streets subject to higher vehicular traffic. Copper shows relative increased contents in this geochemical form in a few samples. This trend suggests that these are the metals most susceptible to mobilise in runoff. Lead associates preferentially with the reducible fraction, which is the host of large contents of Cu, Zn, Cr and Ni. Copper shows affinity to the oxidisable fraction. This geochemical fraction is important in the retention of V, As and Cr, which show increased contents in this form in the samples with the higher contents of these metals. These observations suggest that metals can be considered relatively immobile in street sediments, being subject to mobilisation if changes in pH or redox conditions occur during transport by runoff or after deposition in surface water bodies. All studied metals occur in the residual fraction; relative higher contents are found in samples taken in the periphery of the urban area, but showing relative lower total contents, suggesting a geogenic source. Similar patterns of association of studied metals with geochemical phases were found by other authors in large urban areas.

Geochemical features of human remains (ash residue) as an indicator of the natural and technogenic living conditions of the individual

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Abstract Type Oral presentation

Abstract

We have studied the content of 63 chemical elements, in ash residue of human remains after cremation, by instrumental neutron activation analysis and mass spectrometry with inductively coupled plasma. 103 samples from different Russian cities (St. Petersburg, Novokuznetsk, Novosibirsk, Rostov-on-Don, and Yekaterinburg) were analyzed in this study. All of these cities have high levels of industrial development and high levels of environment pollution. It was found, that the human ash residue of every city has its own geochemical features, which are strongly pronounced. These features are expressed in elevated concentrations of these elements as well as in the correlations between some elements and in modes of occurrence. Ash residue of Novokuznetsk residents, for example, was characterized by high concentration of such elements as Tm, Y, Ho, Er, Dy, Gd, P, Se, Al, As. Ash residue of Novosibirsk residents was characterized by high concentration of such elements as Au. Ash residue of Rostov-on-Don residents was characterized by high concentrations of such elements as Bi, Yb, Ta, Th, Eu, Tb, La, Hf, Rb. Ash residue of St. Petersburg residents was characterized by high concentration of such element as Tb. Ash residue of Yekaterinburg residents was characterized by high concentration of such elements as Br, Cd, Nb, Cs, Sr, Rb, Ni. High concentration of some elements is expected and can be explained. For example high concentration of Au in Novosibirsk ash residue can be the result of Novosibirsk gold refinery operation. Aluminum, As and Se in human ash residue of Novokuznetsk can be explained by metallurgical complexes in the city including smelting industry, with emissions containing Se. Strontium and Br accumulate in human ash residue of Yekaterinburg residents in high concentration. This fact can be the result of petrochemical plant operation. Significant concentrations of Br in soil was detected by scientists in other cities with petrochemical industry. We also determined, that the main mineral of human organism ash residue is hydroxyapatite ($Ca_5(PO_4)_3(OH)$),and it can explained by fact that this mineral makes up about 50-70% of our bones. In addition, we observed mulitiple modes of occurrence of different elements in human ash residue: iron oxides, intermetallic compounds (Zn, Pb, Fe, Ni, Co, etc), barite grains, halite, La, Ce and Th particles etc. The ash residue of humans can be a good indicator of element composition of the human organism as well as an indicator of the geochemical conditions of the territory.

Assessing risks to human health from consumption of vegetables grown in and around urban areas of the Kurdistan region of Iraq

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Abstract Type Oral presentation

Abstract

Vegetable fields in and around urban areas in Kurdistan region of Iraq may accumulate potentially toxic elements (PTEs) from various contamination sources including municipal waste disposal and waste water used for irrigation. The purpose of this study was to assess PTE concentrations in the edible parts of different field-grown vegetables and to assess risks to the local population consuming the produce. In this study 316 vegetables and 96 corresponding soils were sampled from 17 areas around Sulaymaniah, Halabja and Kalar cities. The soils are calcareous (pH 7. 5 - 8.2) and classified as silty loam, sandy or silty clay with total carbon (TOC) contents between 1.40 and 5.47%.

Chromium, Ni and Cu concentrations in soil exceeded EU or UK soil guideline values at one or more locations. However, total concentrations are not representative of the 'bioavailable' fraction that may be readily taken up by plants and DTPA extractions and measurements of isotopically exchangeable metal may better represent this fraction. DTPA extractable and isotopically exchangeable metals were typically low but can be up to ~20% for Zn, Cd and Pb. Sequential extraction suggested that most PTEs were in the residual fraction.

PTE concentrations in the edible parts of the vegetables were highly variable between vegetable types and site. Concentrations of Ni and Cu exceeded recommended UK and WHO/EU limits in almost all vegetables while limits for As were exceeded only in leafy vegetables. Concentration of Cd was above the recommended limits in tarragon and radish leaf, and Pb exceeded the limits in celery, parsley, vine leaf and radish leaf.

Risks to human health were assessed using hazard quotients (HQ) assuming intakes of 0.187 kg/d for adults and 0.118 kg/d for children with body weights of 55.7 and 14.2 kg respectively. HQs ≥ 1 were observed for Cd in tarragon (2.17) and radish leaf (1.15) and for As in radish leaf (1.51) for adults. Risks to children were greater with HQ's for Cd, As and Ni ≥ 1 for vegetables including celery, tarragon, cress, radish and radish leaf, bean, cow pea and garlic. The highest HQs for children were Cd in tarragon (5.38) and As in radish leaf (3.74). Although HQs for individual vegetables suggest elevated risk for both adults and children these are likely to be lower when realistic dietary consumption levels are considered.

Environmental availability of potentially harmful elements in Athens soil

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Abstract Type Oral presentation

Abstract

A recent systematic geochemical survey of top soil in Athens Greece demonstrated that there is a clear differentiation of potentially harmful elements (PHE) according to their origin. Lead, Zn, Cu and Cd reflect the anthropogenic fingerprint on urban soil chemistry while Cr, Ni, Co, Mn and possibly As have a geogenic character linked to the local geology. Furthermore, the geogenic elements were found to be notably enriched compared to other cities worldwide. Here we evaluate the extractability of the studied elements by using various single stage extractions with respect to their pseudototal (aqua regia), potentially phytoavailable (0.05 M EDTA), mobilizable (0.43 M HAc), bioaccessible (SBET) and reactive (0.43 M HNO_3) pools. Soil geochemical parameters such as pH, organic carbon, amorphous Fe and Mn oxide content and soil grain size were also examined as factors controlling the available PHE. The median availability ratios in decreasing order are Cd (44%) > Pb (28%) ~ Cu (27%) > Zn (18%) > Mn (14%) > As (4%) ~ Co (4%) ~ Ni (3%) > Cr (1%) for the EDTA extraction; Cd (74%) > Mn (38%) > Zn (16%) > Co (8%) > Pb (6%) ~ As (6%) ~ Ni (5%) > Cu (1%) for the HAc extraction; and Pb (58%) > Mn (37%) > Zn (29%) > Cu (21%) > Ni (14%) > Cr (5%) for the SBET extraction. Considering their reactivity ratio, PHEs followed a decreasing order of Pb (76%) > Mn (68%) ~ Cd (68%) > Co (32%) ~ Cu (31%) ~ Zn (31%) > Ni (12%) ~ As (11%) > Cr (5%). Overall, the geogenic elements are less available in the Athens soil environment because of their sequestration in stable mineral phases. Empirical multiple linear regression models demonstrate that pseudototal concentration is the predominant explanatory factor of the variability in concentration of the available and reactive pools of the anthropogenic elements. Organic carbon seems to play a significant role in the retention of geogenic elements in soil. The calcareous nature of soil exhibits a dubious effect on the availability of individual elements. However, despite the dominantly alkaline soil pH a considerable fraction of Pb in Athens soil remains in a highly bioaccessible and reactive form. Our results show that combining extractability data with major soil characteristics is essential for understanding the geochemical processes responsible for the fractionation of PHEs in different soil compartments and provide the basis for effective ecological and human health risk assessments in the urban environment. This is particularly important because under the current economic conditions the development of urban agriculture is an emerging initiative of several municipalities of Athens.

Measurement of the solid phase fractionation of elements in road dusts collected from Manchester (UK)

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Abstract Type Oral presentation

Abstract

Sampling - samples were collected seasonally during winter (Jan-Feb 2010) and summer (June-July 2010), at a density of 1 per km2. Road dusts were collected along the edge of the road kerbs, where maximum accumulation of sediments was observed. In each location, a representative area of approximately 100 x 50 cm was carefully swept with the aid of clean dustpan and brush kits. Variable sample sizes were collected depending on sediment accumulation at each site, but for the majority of locations the collected amounts were greater in summer. Samples were stored in self-sealing plastic bags. A selection of 17 road dusts were chosen for sequential extraction.

Sequential Extraction - The extraction vessels employed were Schleicher and Schuell 'Centrex MF-25®' polypropylene centrifuge tubes with 0.45 µm regenerated cellulose acetate membrane filter inserts. Approximately 2 g of each sample was accurately weighed onto a filter tube insert and a 10 mL aliquot of extractant added. Each vessel was centrifuged for 10 min at 1034 G and the resulting solution refrigerated at less than 8 °C prior to analysis for a suite of major and trace elements by ICP-AES. In total, a series of 14 extractions per aliquot of road dust were produced for analysis, covering the extraction concentration range de-ionised (DI) water to 5.0 M acid. The extracts were analysed for the following suite of elements : Al, As, B ,Ba, Ca, Cd, Co, Cr, Cu, Fe, K , Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sr, V and Zn.

Results – The data for the 25 elements, 14 extracts per sample and 17 samples, was assembled into a data matrix of 25 columns by 238 rows and was subjected to a self-modelling mixture algorithm (2) which identified 17 significantly different geochemical signatures in the data. Potentially harmful elements As and Pb had significant associations with 4 and 9 of these signatures. Examination of the extraction profiles, the composition of the geochemical signatures and the interpretations of previous work(1) has been able to confirm the source of the CISED derived signatures and provided additional insights into the formation of the road dusts.

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Health risk assessment of heavy metal intake through the consumption of some common vegetables: a case study in a mining area (Panasqueira mine, Portugal) and its surroundings

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Abstract Type Oral presentation

Abstract

Vegetables cultivated in polluted soils with potentially toxic elements due to industrial activities absorb heavy metals which accumulate in their edible and nonedible parts in quantities high enough to cause clinical problems to humans through their consumption. A field survey was carried out in Panasqueira mine, a Sn-W mineralization hosted by metasediments with quartz veins rich in ferberite with several sulphides. The mining and beneficiation processes produces As-rich mine wastes laid up in two huge tailings: Rio (RT) and Barroca Grande (BGT). The contents of As, Cd, Cr, Cu, Pb and Zn were estimated in potatoes (Solanum tuberosum L.), cabbages (Brassica oleracea L.), lettuces (Lactuca sativa L.) and in the rhizosphere soils, collected on local gardens of four villages: i) downstream BGT (S. Francisco de Assis SFA), ii) downstream RT, suffering the influence of both tailings (Barroca), iii) upstream the tailings and supposedly a non-polluted area (Unhais) and iv) an area considered as background (Casegas). The mean concentrations in soils reveal the following trends of contamination SFA > Barroca > Casegas > Unhais and As > Cu > Zn > Pb while Cd and Cr were mostly below the Portuguese recommended level and the Ontario Guidelines. In vegetables, a similar trend in metal contents was observed, SFA > Barroca > Casegas > Unhais. For cabbages and lettuces the tendency of contamination is roots>leaves and for potatoes is roots > leaves > tubercle. According to the recommended food additives and contaminants levels of FAO/WHO (in mg/kg, As = 0.1, Cd = 0.1, Zn = 40, Pb = 0.3, Cr = 2.3 and Cu = 30), the cabbage leaves were found with 90% of the samples above the recommended level for As, 41.4% for Cd, 58.6% for Zn, 41.4% for Pb, 10.3% for Cr and 6.9% for Cu; the potato tubercles have 64%, 45%, 18% and 9% of the samples above the recommended level for As, Cd, Pb and Cr, as for Cu and Zn they were below the recommended level; the lettuces leaves were found with 100% of the samples above the FAO guidelines for As and Cd, 86% and 71% for Pb and Zn, while for Cu and Cr only 14% of the samples were higher than the recommended levels. The As, Zn and Pb concentrations were found in the order of lettuce > cabbage > potatoes. Mean concentration of Cr and Cu in all vegetables were below the recommended level. In SFA a health risk index (RI) associated with the consumption of vegetables was defined and calculated as the ratio of the estimated daily intake of metals to the oral reference dose for each metal (for a 60 kg body weight adult in μg/kg.d, As = 0.5, Cd = 0.5, Cu = 40, Pb = 3.5 and Zn = 3 00]) being the RI, in descending order, the following: Cd < As < Pb < Cu < Zn. For Cd, As and Pb the RI are higher than 1, meaning there is a potential health risk due to the presence of these elements, while for Cu, and Zn the RI were less than 1. The results indicate that the inhabitants of SFA village are probably exposed to some potential health risks through the intake of high amounts of As, Cd and also Pb via the consumption of locally grown vegetables.

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A case-study on the evaluation of risks for human exposure to potentially toxic elements (PTEs) in urban soils in Portugal

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Abstract Type Oral presentation

Abstract

Considering the large potential impact of an erroneous risk assessment of polluted sites in for example urban areas, various countries (including the UK and the Netherlands) started including contaminants' availability measurements in risk evaluations. Information on the availability of contaminants rather than the total levels is crucial for an accurate assessment of risks since in most soils physical-chemical properties can reduce or increase the available concentrations of contaminants. However, the actual use of information on soil properties on the availability of PTEs in risk assessment in urban settings is still challenging. Ideally, robust but easy extraction schemes are needed to mimic both the soil to plant transfer of contaminants as well as their human bioaccessible fractions. In this study we developed an assessment of risks associated with elevated concentrations of potentially toxic elements (PTEs: As, Ba, Cd, Cr, Cu, Ni, Pb and Zn) in urban soils (n = 45) in Portugal (Porto urban area: around 1,400,000 inhabitants), regarding potential for human exposure. In particular, this included risks associated with direct ingestion of soil as well as consumption of plants and animal products. The evaluation of the availability of contaminants was determined by soil extraction by 0.01 M $CaCl_2$ (OECD TG 106) and 0.43 M HNO_3 (ISO/DIS 17586:2014) and in vitro bioaccessibility tests, namely the Simple Bioaccessibility Extraction Test (SBET) and the Unified Barge Method (UBM)). Results showed that the inclusion of information on the potentially available pool of PTEs in the Portuguese urban soils (in particular, the pool determined by soil extraction by 0.43 M HNO_3) into Freundlich-type empirical models allowed us to identify relevant variables controlling elements' availability for uptake by arable crops. Also, it was interesting to notice that there was a clear relationship between the pools of Ba, Cd, Cu, Ni, Pb and Zn extracted by 0.43 M HNO_3 and their respective human bioaccessibility (determined by both SBET and UBM). We concluded that the approach tested can be successfully implemented in soil risk evaluation in urban areas in Portugal, as well as elsewhere upon testing under variable climatic and geological conditions.

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PTEs and radionuclides of urban soils in public areas of an industrialized town - a case study from Ajka (Hungary)

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Abstract Type Oral presentation

Abstract

Soil quality is a very important factor of the urban ecosystem as soil plays a fundamental role in the biogeochemical cycles along the rock-soil-plant-animal and human pathway, therefore, can influence human health. Urban soils may concentrate contaminants in large quantities due to intensive human activities. In Hungary, during the 20th century, industrial activity (e.g. mining, coal fired power plants, alumina industry) produced a large amount of by-products and pollutants. These contaminants can be enriched in potentially toxic elements (PTEs) and radioactive isotopes as a result of the treatment technologies. Consequences could be PTE and radionuclide enrichment in urban soil of playgrounds and parks. Playgrounds are where children come in contact with soil most frequently, thus, PTEs and radionuclide enrichment in playgrounds are of great concern for children's health. This work focuses on the spatial distribution of PTE (As, Hg, Pb, Cu, Zn, Cd and Ni) and radionuclide (^{226}Ra, ^{232}Th and ^{40}K) concentrations of urban soil at playgrounds, parks and other communal areas in Ajka town (western Hungary) in order to assess the link between contamination sources and the receiving urban soils. Ajka town has a long-established industrial history with multiple contamination sources of heavy alumina industry and coal-based power plants supplied by the nearby bauxite and coal mines, respectively. At 8 playgrounds, 11 parks and 25 other open communal areas soil samples were collected at a depth of 0-10 cm along a 1x1 km grid. The whole grid covers an area of 64 km2. The gamma dose rate was measured on the sampling sites with a FH 40G L10 detector at the surface and at 1 m height. The laboratory analyses include grain size distribution and ICP-OES and CV-AAS method measurements for PTEs of the soil samples, whereas HPGe gamma-ray spectroscopy was used for the radionuclide concentrations of the soil samples. Risk assessment at the 8 sampled playgrounds show that although none of the sampled playground urban soils are contaminated with PTEs according to the Hungarian Pollution Limit Value, about half of them have PTEs concentrations above the Hungarian Regional Geochemical Background (HRGB) value. Our results show that sample sites situated close to the lignite mining area have As, Pb, Ni and Zn concentrations above the HRGB. The most abundant PTE is Ni having concentrations above the HRGB at 7 playgrounds from the 8. The highest gamma dose rate concentrations at the soil surface (180 to 200 nSv/h) and the highest ^{226}Ra concentrations (72 ± 6 to 322 ± 11 Bq/kg) highlight the sampled areas closest to the lignite mining areas and the vicinity of the lignite-fired power plant. The results show spatial correlation of environmental contamination and the contamination sources. The applied integrated urban geochemical method is efficient to study the impact of contamination and it may help with revealing the possibly associated human health risk in an industrial area.

Examining the links between soil geochemistry and health related deprivation indices in London

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Abstract Type Oral presentation

Abstract

There is very clear evidence that that humans are exposed to Potentially Harmful Elements (PHE) in soil (2011a) and that densely populated urban areas contain elevated concentrations of PHEs (2011b). Whilst the amount of PHE that is absorbed into the body can either be measured directly by biomarkers, or indirectly through in-vitro bioaccessibility testing, the actual effects on human health are less easily measured. This study aims to examine possible relationships between the geochemistry of the soils of London with health related deprivation indices.

Methodologies: London Earth is a part of the Geochemical Baseline Survey of the Environment (G-BASE) Project, the British Geological Survey's National Capability in geochemical mapping. Over 6000 soil samples were collected at a density of 4 sites per km2. The <2 mm fraction from the topsoil samples (5–20 cm) were milled, pelletised and analysed by X-ray fluorescence spectrometry (XRFS) for 50 elements.

The Index of Multiple Deprivation 2010 (McLennan et al., 2011) is a measure of multiple deprivations. People may be deprived in one or more of the dimensions. The overall Index of Multiple Deprivation is a weighted area level aggregation of these dimensions of deprivation which are: Income, Employment, Health, Education, Barriers to Housing and Services, Crime and Living Environment.

The relationship between Health deprivation and the geochemistry of the soils has been investigated using machine learning methods including Random Forests.

Main results and conclusion: Preliminary results show that Sn is a significant predictor of health deprivation exhibiting a sigmoidal dose response style of relationship. The significance of Sn as predictor of health outcomes will be discussed and how the relationship between Sn and other PHEs could be used to set soil guidance values for human health.

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Heavy metal like Pb, Cd, Cr and Hg at Man Made Strata in Uruguay

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Abstract Type Oral presentation

Abstract

The aim of this paper is to show the relation between land planning and the identification of anthropogenic soils with an important content of heavy metals, and health problems. Montevideo is the capital of the Oriental Republic of Uruguay, South America, located at the geographic coordinates 34 °53' S and 56 °11' W. It was founded in December 1726 on the coast of the Rio de la Plata. Economic activity in the city was initially dominated by commercial and livestock enterprises. Industrial development commenced in the middle of the nineteenth century leading to development of communications infrastructure including ports, roads and railways, so mining activities began with mining of construction materials, mainly sand and granitic rocks took place outside, but sometimes close to, the Department of Montevideo. In the early twentieth century, extraction of limestone for making lime and portland cement commenced. In the first half of the twentieth century, tanneries, textile mills, paint factories, metal industries, oil depots, brick kilns and other industry developed within the suburbs of Montevideo close to areas that had been mined during the nineteenth century. Due to social, political and economic changes during the 1960's and 1970's most of these industries closed but they left a legacy of contaminated soils in urban, floodplain areas and old abandoned quarries. Over the past fifty years, the city of Montevideo has grown into suburban areas and beyond into former rural areas. As consequences of this urban expansion new areas for civil construction was needed. Many of the chosen areas were geotechnical studied for soil characterization and classification. In this way, in many of them was identified the existences of non natural materials that were replacing natural soils, for at least the first 3 meters. Many of them were developed by infilling of old abandoned quarries. In this sense newly developed areas showed problems linked to poor geotechnical conditions and the presence of heavy metals in both, soils and groundwater. Therefore the geographical distribution of these soils is closely linked to the city growth in the last 200 years, as well as the changes that society has had in relation to industrial and technological development. Data gathered so far for this condition allowed grouping them into three categories: 1) old quarry voids 2) floodplain and 3) the urban area. With further work conducted and the data obtained so far, a classification and new denomination to develop a systematic description of Urban Soils and Soil Technology profiles (man made strata) was designed. These new profiles were sampled for chemical analysis and when possible are classified based on ASTM standards. Chemical analysis results of samples taken along the profiles identified in many of the new areas, were studied considering the distribution of Pb, Cd, Cr and Hg from 0 to 1 meter depth and also those results obtained from 1 to 2 meters depth.

Is 'Urban Medical Geology' a contradiction in terms?

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Abstract Type Oral presentation

Abstract

Medical geology is defined as the impacts of geologic materials and geologic processes on animal and human health. Most urban dwellers, especially in North America and Western Europe, are largely shielded from the natural environment. Most people living in cities work, study, travel, and live in air conditioned spaces, drink municipal or bottled water, eat processed foods purchased at supermarkets, and breathe air tainted by industrial or automotive exhausts. Despite the low profile in many cities, the geologic environment can have important impacts on the health of city dwellers. Climate change has resulted in an increase in dust storms impacting cities in the U.S. southwest, eastern Australia, and eastern China. These storms expose the city dwellers to high burdens of a range of minerals and pathogens that the minerals host. Cities are not immune to natural disasters such as volcanic eruptions, earthquakes, landslides, etc. that expose the population to potentially toxic elements, harmful gases and dangerous minerals. Many occupations in cities expose workers to dangerous minerals and trace elements that often adversely impact their health. Analytical tools used by geoscientists and databases that they create can be useful in identifying trace element anomalies in soil, air, and water created by anthropogenic activities, determining their source(s), and modes of occurrence. In short, medical geology is an active, but under-recognized, field of study in urban communities around the world. As urban areas are commonly the centers of population, education, medical facilities, and financial and political power, it is essential that the decision makers are aware of the importance of urban medical geology.

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05

Urban medical geology

Urbanization and childhood speech and language disability in Taiwan

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Abstract Type Poster

Abstract

Speech and language disability (SLD) is not uncommon in children. However, data at the national level are limited, and effects of urbanization are seldom evaluated. Starting from 1980, the local governments in Taiwan has begun to certify disabled residents for providing various services and report cases to the central government according to the law, and the central government maintains a registry of reported cases, which provides a unique opportunity for studying SLD at the national level. Using the registry data from 2004 to 2010, we calculated the prevalence of SLD by age, gender, and degree of urbanization of the residing area. The trends of changes in prevalence over the study period were also assessed. Because the government discourages the certification under 3 years of age, we excluded cases under 3 years old from the analyses. We found that from 2004 to 2010 the registered cases between 3 and 17 years old increased from 1418 to 1637 per year, and the prevalence generally increased every year in all age groups except in 12-14 years of age. In each year there were more boy cases than girl cases, and the prevalence rate ratio increased from 1.50 to 1.83 ($p < 0.05$ in all years), with an increasing trend over time ($p < 0.01$). Over the years, a higher prevalence was observed in rural areas where the degree of urbanization was lower, and the rural-to-urban prevalence rate ratio increased from 1.35 to 1.71 ($p < 0.05$ in all years), with an increasing trend over time ($p < 0.01$). Further studies identifying the risk factors contributed to the increases might help the prevention of SLD in the future.

Natural radioactivity in municipalities from Pegmatite Borborema Province (Northeastern Brasil)

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Abstract Type Poster

Abstract

This abstract presents the preliminary considerations of a study accomplished on domestic radon that occurs in municipalities from the pegmatite bodies of the Seridó Region of Pegmatite Borborema Province, State of Rio Grande do Norte, Brazil and their influence on the population nuclei of the area of the Parelhas, Equador and Lages Pintadas cities. In general, the pegmatite from the area of Pegmatite Borborema Province present high environmental radioactivity due to the dispersed uranium in the crystalline structure of pegmatite minerals, as primary and secondary uranium minerals. These uranium minerals are associated with the fracture and voids in the pegmatite and in the tourmaline-bearing granite. Some municipalities from this region have presented in recent years high mortality levels for different types of cancer when compared with the indices of cities from other regions of the Rio Grande do Norte state (Brazil). The main health hazard from high radon exposure is an increased risk of lung cancer. Domestic radon has been identified as the most important environmental risk factor for lung cancer. Indoor radon measurements were made using long-term passive radon detectors (E-PERM® by RADELEC INC.), and gross gamma radiation with a RS-230 spectrometer (TERRAPLUS). We present the data from 955 long-term passive E-PERM® eletret type detectors installed in 855 dwelling (mainly-bedrooms). The survey was performed during six months in the dry season (September-February) in the main bedroom of each surveyed dwelling where the electrets were placed under the bed (≥30 cm high). All dwellings are un-ceiling and have ceramic roofs, while the floor is tiled or cemented. The choice of different dwellings was random (distributed between urban and rural areas) and in 10% of dwellings two passive detectors were installed to reduce the risk of erroneous results due to failure of a detector. The experimental uncertainty of radon concentration measurements using E-PERM® electret ionization chambers is better than 10% at one sigma. The gamma radiation level was also checked in each dwelling using a RS-230 spectrometer. For the 855 investigated dwellings the domestic radon ranged from 12 to 4578 Bq/m^3 (MED: 174; AM: 318; SD: 309). The gamma radiation level was also checked in each dwelling and ranging: 16 to 159 nGy/h (MED: 85; GM: 83; SD: 18), this data was considered normal in reference to average superficial gamma radiation of Earth (50nGy/h). Therefore, 85% of the studied dwellings exceed the WHO action level (100 Bq/m^3) with the respective cancer probability ranging from 0.15 to 70.53% (MED: 2.68; AM: 4.89; GM: 3.09; SD: 957). It is clear from these results of the present work that for these municipalities, further and more extensive research is needed.

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06

Modeling, mapping and monitoring of environmental hazards and diseases

Assessment of geochemical factors in multiple sclerosis distribution in the south-western Sardinia

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Abstract Type Oral Presentation

Abstract

South-Western Sardinia (SWS) is a high risk area of MS with prevalence of 210.4/100,000. Moreover, the existence of geographical clustering was demonstrated. An unexpected high prevalence was found in a band located in the upper part of SWS, particularly in the municipality of Domusnovas. Considering that no reasons for genetic difference compared to other Sardinians are present in this municipality, it could be hypothesized a role of the environment. SWS is an interesting area, because its population is representative of the Sardinian one (genetically homogeneous) and presents a peculiar environment related to the industrial, ore deposits and military economy. The aim of the study was to evaluate the role of geochemical factors on geographical distribution of MS in SWS. The standard morbidity ratio of each municipality was used to indicate the deviation of the MS distribution in relation to the global prevalence of the area. The analytical data regarding the following elements: Co, Cr, Cu, Mn, Ni, Pb, Zn, were available for each SWS municipality. They derived mainly by stream sediment samples of the Geochemical Strategic Prospecting of Sardinia (1972-1974) and were analyzed by Atomic Absorption Spectroscopy (AAS). Epidemiological and geochemical data were geo-referenced with a geographic information system (GIS). Correlation matrices were calculated to evaluate the correlation between MS and geochemical data. The geographic distribution maps of the following chemical elements have been obtained: Co, Cr, Cu, Mn, Ni, Pb, Zn and integrated with the MS distribution in SWS. No significant correlations between Co, Cr, Cu, Mn, Ni, Pb, Zn were found considering globally the distribution of the disease. A mild correlation (r = 0.4; p = 0.001) was present with Cu and the distribution of the disease in the male gender. The predominant spread of MS in industrialized countries where pollution by heavy metals and CO poisoning is widespread suggests a relationship among toxic action of metal pollutants and MS. In this study we use the geo-epidemiological approach to search environmental factors which could be associated to MS distribution. In particular, we observe a mild correlation between SM and Cu in male. This is a preliminary study aimed at generating hypothesis that will need to be confirmed in further researches.

The regional geogenic radon map of the Portuguese territory: current status

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Abstract Type Oral Presentation

Abstract

Radon gas is known as a potential carcinogen, increasing the probability of lung cancer in humans, in particular when it occurs in high concentrations, as stated by the main health organizations (e.g. WHO). Within the European Union some efforts have been made to reduce the risk associated with radon inhalation in different countries, with efforts usually focused on prevention measures. One of these measures is the preparation of risk maps which can be used for land use planning. These maps, reflecti the radon potential of the underlying geological units and are called regional geogenic radon mapsA coordination team has been set up to set a common methodology to be applied to all European countries subsequently allowing the elaboration of a global geogenic map. However, in countries with small databases or strongly heterogeneous distributions of soil-gas radon, some adaptations must be made to the proposed methodology so far. This is the case of the Portuguese territory, and the main objective of this work is to discuss the present status of this goal. The focus should be on the geological units and not on administrative boundaries as is usual in this type of study. Aside from soil-gas radon, other types of data can be used, such as the U content and exhalation radon rates. Some preliminary results have already been obtained in the northern and central part of Portugal of the Hesperian Massif. This is mainly composed of Pre-Hercynian to Hercynian granites (subdivided according to mineralogy in two mica and biotite granites, and according to the time of emplacement into syn-tectonic and post-tectonic groups) and Pre-Cambrian/Cambrian to Paleozoic metamorphic rocks. The U-content and soil-gas radon concentrations obtained show large variability, the lowest values corresponding to metamorphic rocks. The Hercynian porphyritic biotite granites show the highest values in the dataset for both variables, which is in good agreement with previous indoor radon data obtained in dwellings built on the same type of bedrock. These show the highest average radon concentrations in the Portuguese territory.

Exposure of geogenic elements in drinking water and public health; Study possibilities in Denmark

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Abstract Type Oral Presentation

Abstract

Although the chemical universe is broad, and most chemical substances do not occur exclusively in drinking water, water is essential for life, and exposures to chemical substances in drinking water, even at low concentrations, may have important consequences across the entire population (Villanueva et al., 2014). In Denmark, drinking water is entirely based on groundwater. The drinking water supply system is decentralized consisting of approximately 2,700 larger water supplies and 70,000 smaller private waterworks. Water quality can be assessed with a high degree of certainty for the major part of the population. Drinking water quality is monitored routinely, and data on drinking water quality have for decades been archived in the public-available database JUPITER. Assessing the health impacts of geogenic natural occurring elements in drinking water requires sufficient data on life-long exposures. Thus, high-quality data on both spatial and temporal variation of drinking water quality are of paramount importance when assessing public health related to geogenic exposures. In addition, utilizing Danish nationwide population-based registers, we can identify the exact geographical residential location from 1978 onwards on a personal level and link this information with later health outcomes. The combinations of these unique data sources allow a longitudinal population-based assessment of the potential health impact of drinking water quality. These data are available through the National Centre for Integrated Register-based Research at Aarhus University (Pedersen et al., 2006). Here, we'll present an overview of the drinking water quality data on specific geogenic elements during the last almost 100 years and show how the amount of data increased since the 1980s. The aim is to combine drinking water quality data in the Danish geo-database JUPITER with the health data available at the National Centre for Integrated Register-based Research at Aarhus University (CIRRAU). Finally we will present examples where we combine the data and analyze the association between drinking water quality and human health.

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Geochemical features of limescale as an indicator of drinking water quality and factor of influence on public health

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Abstract Type Oral Presentation

Abstract

Numerous researches reveal that the quality of drinking water is defined by its chemical composition. Moreover, quality of consumed drinking water has a significant impact on public health. The existing techniques assume one-stage selection and analysis of the chemical composition, thus the assessment of long-term intake of chemical elements in a human body is not carried out. In our opinion, salt deposits (or limescale) forming in household conditions in the heat exchanging equipment at water boiling are capable to show this process. We collected and processed a representative base on the element composition of drinking water limescale from various regions of Siberia, Urals and Kazakhstan, which are characterized by different geological structure, landscape and geochemical conditions and anthropogenic load. The main method of determining element composition was instrumental neutron activation analysis (INAA) on 28 chemical elements. We divided all studied regions into two types on the geological structure: 1) mountain-folded and 2) platform areas. Rationing of regional average values of chemical elements content in the limescale to that obtained from water of Baikal taken as background values shows that each region has its geochemical specialization. Thus, the common elements specific for all regions are Zn, Fe, Ag, which concentration coefficients (CC) range within wide limits. In addition, Zn takes the leading role in all geochemical series. The interesting point is that the minimum (58) and maximum (916) values geographically are in the Baikal rift zone. The minimum CC observed in the Tunka Basin, located in the south-western flank, the maximum CC is in Barguzin basin from the east side of Baikal. The revealed geochemical specifics of drinking water limescale correlate sufficiently with the features of the geological structure and metallogeny of territories. The good example is the mountain-folded regions. Thus, the samples of the limescale from Gorny Altai are enriched with Cr, As, Sb (CC>1). We found high levels of CC for U (from 6 to 16) in samples taken in the intermountain basins of Baikal region. These data correlate rather well with the geological data. This area has a high potential to detect U ore occurrences. Rifting processes in Barguzin basin manifest themselves in the element composition of the limescale. In this area, CC had the highest values, moreover list of elements with CC > 1 is 18 of 28 studied. Rifting reflects in the enrichment of the limescale with rare, rare earth and radioactive elements. Such high rates of chemical elements accumulation in the drinking water limescale, according to our data, are in correlation with general and specific incidence. So, we found a significant correlation between Zn in the limescale and and blood diseases in Pavlodar region. We are of opinion that the drinking water salt deposits may be used for water quality assessment and forecast of diseases.

FOGO2014: Geochemistry of dust particles and air quality monitoring during the Fogo 2014 eruption (Cape Verde)

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Abstract Type Oral Presentation

Abstract

Volcanic eruptions produce hazardous effects on the environment, climate, exposed populations health, and are associated with the deterioration of social and economic conditions. The unfavorable effects of a volcanic eruption depend on the distance, magma viscosity and gas concentrations. The hazards closer to the volcano include toxic volcanic ashes causing problems in the respiratory system, eyes and skin. These also lead to the deterioration of the water and air quality, scarcer rain events and soil contamination. During volcanic eruptions and their immediate aftermath, increased respiratory system morbidity has been observed as well as mortality among those affected by volcanic eruptions. Unfavorable health effects could be prevented by application of safety measures. Fogo island (Cape Verde archipelago), located in the Atlantic Ocean ~800 km westwards of the Senegal coast, is the fourth biggest island (476 km^2) of the country. The origin of the archipelago is related to the Cape Verde hotspot magmatism, which encompasses alkaline silica-undersaturated melts of basanitic to tephritic composition. Fogo, together with Brava, are the youngest (~5 Ma) and the most active seismic islands of the country. Fogo island is an active stratovolcano with a maximum altitude of ~2,830 m above the sea level (Pico do Fogo). The last eruption occurred on November 23, 2014, after 19 years of inactivity. The lava expelled by the current eruption (still active on 2015 January 15, but declining) destroyed two villages, previously evacuated, and covered vast areas of agricultural land, causing very large economic losses. Although the eruption caused no deaths, large amounts of gases and dusts were expelled. The Collaboratory for Geosciences (C4G), a research infrastructure created in 2014 in the framework of the Portuguese Roadmap for Strategic Research Infrastructures, supported the Cape Verdean authorities by co-monitoring the eruption. The objective of this work focuses the air quality monitoring and outdoor dusts collection, that was performed by a C4G team and also by the Meteorological and Geophysical National Institute (INMG, Cape Verde). A detailed description of the monitoring efforts carried out during the eruption and the initial results of the data collected, will be presented. This monitoring effort carried out at the request and in collaboration with INMG, was made possible by an emergency financial support provided by Fundação para a Ciência e Tecnologia, Portugal to C4G.

Urinary arsenic biomonitoring results indicate exposure to inorganic arsenic from private drinking water supplies in Cornwall (South West England)

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Abstract Type Oral Presentation

Abstract

Chronic exposure to arsenic (As) through drinking water is known to cause cancerous and non-cancerous health effects (NRC, 1999, IARC., 1987). Cornwall, UK is a region with high concentrations of environmental As (Mitchell and Barr, 1995) and previous studies found elevated concentrations in urine (Kavanagh et al., 1998), hair (Peach and Lane, 1998) and toenails (Button et al., 2009) of some local residents. Private water supply (PWS) usage is common in Cornwall with an estimated 60,000 people served (DWI, 2013). A sampling programme of 512 households across Cornwall conducted by the British Geological survey and Public Health England found 5% of drinking water samples exceeding 10 µg/L, the UK As Prescribed Concentration or Value . The survey presented here used non-invasive urinary biomonitoring to (1) quantify human exposure to inorganic As, (2) assess the importance of PWS as an exposure route and (3) explore the effects of adjustment factors required to optimise reliability of spot-urine data. Data will be presented for 207 volunteers from 127 households having provided a drinking water sample for total As determination by ICP-MS, a first morning void (FMV) or spot urine sample for As speciation by HPLC-ICP-MS plus creatinine, specific gravity and osmolality analysis. Ongoing work will relate As uptake to other exposure routes and underlying geology while assessing long term exposure of volunteers with toenail and hair biomarkers. Funding provided by NERC via a University of Manchester/British Geological Survey University Funding Initiative (BUFI) PhD studentship (Contract No. GA/125/017, BUFI Ref: S204.2). Ethical approval was provided by the University of Manchester Research Ethics Committee (Ref 13068) and the NHS Health Research Authority National Research Ethics Committee (NRES) (Ref 13/EE/0234).

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The geochemical quality of soils in the Clyde basin, Scotland, UK – main controls and anthropogenic impacts

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Abstract Type Oral Presentation

Abstract

The distribution of potentially harmful substances in soils is of growing concern under current environmental protection legislation because of their potential impacts on water quality, ecosystem and human health. Equally there are concerns over food security and the ability of soils to provide essential trace elements and nutrients to agricultural crops and animals. Recently, the British Geological Survey's (BGS) Geochemical Baseline Survey of the Environment (G-BASE) project carried out extensive surveys of rural and urban soil quality in the River Clyde catchment (Clyde basin) on the west coast of Scotland. The Clyde basin is interesting as it extends from a rural upland environment in the south, to the River Clyde estuary in the north. The catchment contains an historic lead mining area known as Leadhills that was active until the mid 20th century. In addition, the estuary and lower reaches of the river formed the transport and shipping links that drove the development of Scotland's main conurbation – the city of Glasgow, which is centred on the River Clyde. Glasgow was a major industrial powerhouse during the 18th-20th centuries and a centre for coal mining, shipbuilding, metal manufacture and heavy engineering. Although heavy industry and mining have now declined, the newly available G-BASE soil datasets demonstrate the impacts of urbanisation and the post-industrial legacy of the Glasgow conurbation as well as of historical mining activities on environmental quality. The survey results reveal metal concentrations in urban soils are typically up to 2.5 times (median values) that of rural soils as a result of pollution. Conversely, the distribution of essential trace elements for agriculture such as selenium and iodine are largely controlled by natural processes. The data allow for better assessment of soil-quality related risks to ecosystem and human health to aid land management and environmental protection in the heavily populated River Clyde catchment.

Naturally occurring asbestos near populated areas of southern Nevada, USA: unusual occurrences of fibrous libby-type Na-amphibole and actinolite

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Abstract Type Oral Presentation

Abstract

Naturally occurring asbestos (NOA) is often disseminated through geologic materials and may not be readily apparent in outcrop. Thus, identifying the geologic settings and processes responsible for NOA genesis is a critical first step in ultimately mitigating human health risk from NOA. Here, we report on unusual occurrences of amphibole NOA that would not be predicted based on current models for fibrous amphibole genesis.

Fibrous $NaFe^{3+}$-amphiboles have been implicated in high rates of death and disease at Libby, Montana, and form primarily by alkali metasomatism by magmatic fluids expelled from carbonatite or peralkaline silicate magmas. Fibrous actinolite primarily forms by metamorphism or hydrothermal alteration of mafic or ultramafic protoliths. Fibrous $NaFe^{3+}$-amphibole (winchite, magnesioriebeckite, richterite) and actinolite is associated with faulted Miocene plutons that crop out within and adjacent to urban areas of southern Nevada. These plutons are dominated by metaluminous biotite, hornblende-bearing quartz monzonite. The fibrous amphiboles are found as fracture-fill veins and as replacement of magmatic hornblende, and formed from high fO_2 hydrothermal fluids which circulated through active fault zones as plutons cooled through subsolidus temperatures. Fibrous $NaFe^{3+}$-amphibole is found in the Wilson Ridge pluton in AZ, where hydrothermal fluids produced hypersodic conditions; halite deposits in adjacent Miocene sedimentary basins are the likely source of Na. Fibrous amphiboles associated with Miocene plutons in southern Nevada (plutons at Boulder City, Black Hill), where hydrothermal fluids lacked hypersodic enrichment, are dominantly actinolite (plus magnesiohornblende). Fibers from all plutons are <1.0 µm in diameter (typically <0.5 µm) and vary from tens to hundreds of microns in length, capable of dust transport and human inhalation.

Eolian and alluvial erosion of the plutons have significantly increased the distribution of the fibrous amphiboles into surrounding alluvial fans, eolian dunes, and soils. Six soil samples were analyzed by polarizing light microscope and transmission electron microscope using a Fluidized Bed Asbestos Segregator preparation method of sediment for analysis. Measured concentrations of fibrous amphibole (plus erionite) were as high as 4.5 x 108 structures per gram. Actinolite fibers found at the Nellis Dunes Recreation Area approximately 35 km north of pluton sources are interpreted to have been transported there by wind. The primary pathway for human exposures from NOA is through dust emissions, which are particularly problematic in arid regions. Increased dust emissions from both natural wind and anthropogenic activities, greatly increases the potential for human exposure in the Las Vegas metropolitan area (over 1.9 million people). A recently published epidemiology study (Bauman et al. 2015, J. Thoracic Oncology) using southern Nevada cancer data suggests an environmental exposure to fibrous minerals.

Risk assessment for hazardous geological processes and their impact on public health in Ukraine

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Abstract Type Oral Presentation

Abstract

Development of hazardous geological processes in Ukraine (landslides, karst, flooding, abrasion, debris flows, sedimentation, subsidence of loess soils, earthquakes), causes significant economic and environmental damage, complicates the development of new areas and often causes disability and mortality of population. In Ukraine there are about 700 settlements (including Kyiv, the capital of Ukraine, Odesa, Chernivtsi, etc.) that need to be protected from hazardous geological processes, generally from overall action of several of them. Considering the significant effects of Ukrainian territory by hazardous geological processes and their periodic activation, caused by cycles of solar activity, the development of preventive measures and calculations for manifestations and consequences of hazardous geological processes became significantly relevant. The aim of our research is to determine spatial and temporal regularities of hazardous geological processes development, to study their formation mechanisms, evaluate the impact of factors, which cause them, to create monitoring system for manifestations of hazardous geological processes within the affected areas, to model the impact of hazardous geological processes on different objects of national-economic purpose, to assess impact risks of hazardous geological processes on public health, and to implement engineering measures in order to protect areas and minimize negative impact on public health.

Governing factors and implications of spatially varying drinking-water iodine concentrations

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Abstract Type Oral Presentation

Abstract

The attention towards contaminants in the drinking water has increased significantly worldwide, whereas the beneficial effects of drinking water quality are largely ignored. Drinking water is a potential source of essential and possibly essential elements for humans. Iodine is an example a such drinking water constituent which is essential for human health. The focus worldwide falls mainly on the iodine deficiency, as it is "the single most important preventable cause of brain damage" according to WHO. Some evidence for substantial spatial variation of iodine in Danish drinking water, which is entirely of groundwater origin, existed, but comprehensive hydrogeochemical or geostatistical studies were lacking. Thus, a Danish GEOCENTER project was conducted between 2011 and 2014. The main objectives were (1) to map iodine concentration and speciation in drinking and ground water in Denmark, (2) to study the spatial patterns and the governing factors, and (3) to evaluate the importance of the spatial variation of drinking water iodine to the populations' nutrition (health). Two types of data were used for fulfilling these objectives: (1) from two sampling campaigns designed as part of this project, and (2) historical groundwater data (two datasets: 1933-2011 and 2011-2014) extracted from the public geological and hydrological database, Jupiter. The samples from the sampling campaigns were analysed for iodide, iodate, total iodine and the major constituents. Only total iodine data was present in the historical datasets. An overview on major findings from the project will be presented here. The focus area is complex spatial variability of both iodine concentration and speciation, and how this is reflected in human dietary iodine intake. An estimation of the percentage population exposed to different levels of iodine via drinking water will be presented. The underlying geochemical processes controlling iodine speciation and concentration in groundwater will also be discussed, demonstrating that concentration and speciation are site and depth specific and governed by different geochemical processes at different concentration levels. The findings of this Danish GEOCENTER project provide the only comprehensive nationwide overview on iodine related topic for Denmark (since 1968) and are, therefore, of major interest. Moreover, the observed spatial variation of iodine in drinking water (of groundwater origin) poses a challenge for efficiency of universal iodising programs also beyond Denmark.

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06

Modeling, mapping and monitoring of environmental hazards and diseases

The influence of Quaternary geology and land use on ^{137}Cs levels in Sweden after the Chernobyl nuclear power plant accident

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Abstract Type Poster

Abstract

After the Chernobyl nuclear power plant accident, in 1986, rather high levels of ^{137}Cs radiation were detected in the Gävle municipality in Sweden. The clouds contaminated with radioactive debris from the accident had produced a fair amount of showers resulting in the deposition of ^{137}Cs in the NE of Sweden. The most affected areas were almost immediately the subject of aerial gamma spectrometry measurements performed by the Geological Survey of Sweden. Later aerial measurements have made it possible to gradually create a more detailed digital map of ^{137}Cs backdated to early May 1986. The initial measurements and the later digital map were interpolated by Krieging, separately and then adjusted so that the resulting grid points coincided. Both ^{137}Cs data sets were superimposed onto a map depicting the Quaternary geology as well as onto another map of land use. The numerical difference in each grid point between the two geophysical maps of ^{137}Cs was calculated. A small difference indicated lingering of radiation and a large difference could be explained by wash-off from hard surfaces or migration in the soil. These differences in each grid point were super-imposed onto the maps of Quaternary geology and land use, respectively. Mean and standard deviations on the differences in ^{137}Cs values between the two data sets were finally calculated for the different soil types and types of land use, respectively. A spatial pattern was identified where the soil types seemed to influence the amount of lingering radiation e.g. peat bogs having low mean values and clays having high mean values indicating that the ^{137}Cs remained to a higher extent in the peat bogs than in the clay. Also the human influence seemed rather important with a similar pattern where low mean values were seen in forested areas compared to high values in the inhabited zones, with agricultural land in between. Therefore, long-term external radiation from ^{137}Cs, and the subsequent potential health hazards, does not only depend on the physical decay of ^{137}Cs, but also indirectly of geology.

Environmental risk assessment based on high-resolution spatial maps of potential toxic elements sampled on top soils of Santiago (Cape Verde)

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Abstract Type Poster

Abstract

Geochemical mapping is the baseline knowledge required to identify the regions of the planet with critical contents of potentially toxic elements from either natural or anthropogenic sources. Sediments, soils and waters are the vehicles which link the inorganic environment to life through the supplying of essential macro and micro nutrients. The chemical composition of surface geological materials may cause metabolic changes which may favour the occurrence of endemic diseases in humans. In order to better understand the relationships between environmental geochemistry and public health, we present environmental risk maps of some harmful elements (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, V, and Zn) in the top soils of Santiago, identifying the potentially harmful areas in this island. The Estimated Background Values (EBV) of Cd, Co, Cr, Ni and V were found to be above the Canadian guidelines both for agricultural and residential purposes of soils and also above the target values of the Dutch guidelines. Associations between the geological formations of the island and the composition of top soils were identified and confirmed by descriptive statistics and by Principal Component Analysis (PCA). The EBV spatial distribution of the metals and the results of PCA allowed us to establish relationships between the EBV maps and the geological formations. The metals with higher loadings in the first Principal Component (Ni, Cr, Co, Cu, and V) clearly show the influence of a lithology rich in siderophile elements, typical of basic rocks and of its related minerals. The elements with higher loadings in the second Principal Component (Mn, Zn, Pb, As, Hg, and Cd) are chalcophile elements, except for Mn, but an anthropogenic source for these elements cannot be ruled out.

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Mercury contamination in sediments and soils from historic gold mining sites in Lavras do Sul (RS, Brazil)

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Abstract Type Poster

Abstract

Lavras do Sul county is located in the western upper reaches of the Camaquã River basin, which drains the shield region of Rio Grande do Sul State, in south Brazil. Gold deposits in the area were first discovered in 1799, while mining and processing of gold ores using Hg amalgamation, either by milling facilities or by individual miners, occurred intermittently in the early 1900's, in the 1940's and in the period 1982-1991. Although no gold extraction is presently going on, the interest of mining companies prospecting for gold have re-appeared in Lavras do Sul. Other economic activities are mainly cattle and sheep raising, and, locally, rice culture in some alluvial deposits. Previous works in the area reported persistence of Hg contamination in soils around old milling facilities, high concentrations of Hg and other contaminants, such as As, Pb, and Cd in these soils and in stream sediments, and predominance of the volatile elemental Hg form in sediments and soil samples. This work presents recent data from soils and sediments, since the last sampling occurred in 2004. In order to generate time comparable data, analytical and sampling procedures are similar to those of the first works in the area. In September 2013, ten samples of stream sediments and seven of surface soils were taken and wet sieved for separation of the silt-clay fraction in which total metal concentrations were determined. Total Hg was analyzed by hydrate generation and AAS, after digestion with HNO_3 and HF in closed system, according to EPA 3052. Total Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn were determined by ICP-AES after extractions in open system with HF, HNO_3, $HClO_4$ and H_2O_2. Reference materials were used for quality analytical evaluation (CANMET STSD-4 and NIST for Hg). Results showed that the most contaminated soils were those around the ruins of the Chiapetta mill, located in the urban area of Lavras do Sul. Concentrations reached 12500 ng/g Hg, 71.43 µg/g As, 1210 µg/g Zn, 22310 µg/g Fe, 261 µg/g Mn, 5.38 µg/g Cd, 12.7 µg/g Ni, 11.1 µg/g Co, 383 µg/g Pb, 70.0 µg/g Cu and 21.3 µg/g Cr, indicating similar or worse contamination as compared to the values found in 2004, at the same site. The most contaminated stream sediments were those downstream from the Cerro Rico Mill, reaching 2105 ng/g Hg, 102.6 µg/g Cu and 113.3 µg/g Zn. Regarding sites distant from milling facilities, site H2 from the Hilário Stream surprised with a Hg concentration of 261 ng/g, the highest value found at this site in comparison with values from the 1992-1996 sampling period. Future studies considering dietary consumption of fish, meat and the causes of death in the human population of Lavras do Sul would be important to verify possible links with environmental contamination. Thanks to CNPq, FEPAM and to UFRGS CPGq and Soils laboratories.

Present state and look at the past: relationship between geochemical composition of Vilnius preschools environment and children hair

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Abstract Type Poster

Abstract

Soil contamination level in urban territories of Lithuania is estimated using monoelement indices Ko and total contamination index Zd (HN 60:2004). Ko is determined comparing the contents of potentially harmful chemical elements with maximum permitted concentrations and characterises geohygienic state of soil. Zd is calculated by summing up the enrichment factors of harmful chemical pollutants and characterises possible health response of the residents, primarily children, to environmental contamination. This index was introduced in 1986-1987, when geohygienic state of topsoil around Vilnius preschools was compared with health indices of children (Krasilščikovas et al., 1988). The study showed that in areas with moderate pollution (16 < Zd < 32) compared to relatively clean areas (Zd < 16) the respiratory diseases, the number of sick days and the total sickness rate significantly increased for two studied age groups of children (1-3 and 3-6 years old). At that time the hair samples of more than 100 children attending 8 preschools were also taken. They were stored for analysis by prospective more modern equipment.

In 2007, topsoil samples (fraction <0.63 mm) from the areas of 49 Vilnius preschools were analysed by OEA. Nearly half of the analysed areas (21 out of 49) had moderately hazardous to hazardous levels of contamination as indicated by the total contamination index (Kumpienė et al., 2011). After two years topsoil samples from the areas of most of these preschools were analysed again by selecting the fraction <2 mm which is used in practice of European geochemical research (Reimann, 2003). For determination of chemical composition, the energy-dispersive x-ray fluorescence (ED XRF) analysis was used. Additionally, in 2012 in the areas of 56 preschools the samples of epiphytic lichen Phaeophyscia orbicularis (Neck.) Moberg from lime and maple trees were collected and analysed by the same ED XRF equipment. In 2013, this equipment was also used for analysis of the chemical composition of children hair collected in 1986-1987.The contents of the following elements were determined by ED XRF in topsoil, lichen and hair: 12 heavy metals or other potentially harmful elements As, Ba, Co, Cr, Cu, Mn, Mo, Ni, Sn, Pb, V, Zn, 10 major elements Al, Ca, Fe, K, Mg, Na, S, Si, Ti, P, and seven other elements W, Zr, Ga, Nb, Th, Sr, Rb. The results of children hair analysis are accompanied by comprehensive questionnaire data of their owners: sex, birth date and place, dwelling-place, time of preschool attendance, workplace of parents, etc. Analytical results of various sampling media were compared. Not only conventional mathematical statistical methods were applied for data analysis, but also methods of visualisation by GIS. These results will be demonstrated during the conference.

Self-depuration ability of surface water in a transboundery watershed – the Águeda river

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Abstract Type Poster

Abstract

The goal of this research study is the characterization of surface water quality of the Águeda River, Douro Watershed, Portugal-Spain, namely the study of pollutants dispersion. Simulation of different quality scenarios was undertaken using Qual2Kw software and the river's self-depuration ability discussed in the typeface of the obtain results. Pollutant loads reaching water's neighborhood changes the existing physical, chemical and biological mechanisms altering behavior and concentrations of different elements. The following chemical parameters were analysed: biochemical oxygen demand (CBO_5), dissolved oxygen concentration (DO), dry residue, Ptotal, Ntotal, pH, temperature and microbiological parameters. The biochemical oxygen demand (CBO_5), dissolved oxygen concentration (DO) and the microbiological parameters were used as indicators for the presence of organic matter and as parameters for evaluating environmental pollution. Data was obtained during May of 2012 according to a previous defined sampling design along the Águeda River and its principal tributaries. Self-depuration must be understood as an ecological phenomenon aiming to restore the natural watercourse balance. This ability depends on the quality and the quantity of topical and diffuse inflows. The obtained model's calibration was in the 95% confidence intervals for most of the analyzed parameters. The obtained scenarios, mainly revealed good water quality for the biological parameters. In a second step a prediction scenario were built, intending to assess firstly, the influence of accidental discharges of pollutants in specific point sources, and secondly to analyze the influence of minimum flow values, which could represent the picture of an extremely dry year. The two considered scenarios revealed that self-depuration is extremely dependent on minimum flow rates. The properly calibrated QUAL2Kw turned out to be a suitable tool for building a diffusion model for the most important biological pollutants. After calibration and validation, it is an excellent exercise in the construction of predictive scenarios which helps decision-taking entities to characterize and manage the hydrological response both in space and in time.

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07

Advances in analytical methods

Bio-spectroscopic characterization of foreign body materials: case studies and biomedical devices

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Abstract Type Oral Presentation

Abstract

Foreign bodies can be defined as any exogenous object that has been introduced into the tissues or cavities of the body and is not rapidly absorbed. Unintended human exposure to various types of solid materials can arise from a multitude of sources including environmental pollutants, failure of implanted medical devices, or as a result of wartime or crime related injuries (e.g., bullets and embedded fragments). Foreign body biomaterial may be defined in this context as any material used in a medical device that is intended to interact with living systems. Accurate identification, quantification and chemical characterization of foreign body biomaterials released from the used of medical devices are often valuable adjuncts to gain fundamental understanding of the local and systemic biological response to various elemental and compositional materials, and to aid on defining the diagnosis of a disease state. Characterization of biomaterials in tissues may proceed in a variety of ways but generally can be classified as four types: 1) histochemical and/or optical (light) microscopy, 2) chemical analysis (organic and inorganic), 3) ultrastructural methods (i.e., scanning electron microscopy with energy dispersive X-ray microanalysis), 4) and spectroscopic techniques.

Recent technological advances in optical instrumentation have led to the development of new microprobe techniques that are capable of providing in situ analysis, chemical distribution (mapping), and quantitative information of foreign body biomaterials in tissues and other related samples. Chemical and molecular spectroscopic techniques, such as Fourier transform infrared microscopy and Raman microprobe spectroscopy, provide accurate, rapid and selective identification by virtue of a molecule's characteristic spectrum of vibrational frequencies.

In this presentation, several successful examples in which these biospectroscopic modalities have been used to characterize biomaterials in tissues will be described. (1-4) Silicone (poly tetramethylsiloxane) was observed in breast biopsies, lymph nodes and capsular tissues from patients having undergone breast implants. The presence of these small inclusions in distant sites (such as lymph nodes) argues against the chemical inertness of the polymer. Inclusions of other polymers associated with the use of these types of bio-medical devices were also mapped. Clearly the identification and chemical mapping of such materials have implications on the engineering of biomaterials.

Suggested reading

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Recent development of novel Zr-oxide based binding gels in diffusive gradients in thin films (DGT) for measurements of bioavailable chemicals in the environment

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Abstract Type Oral Presentation

Abstract

The technology of diffusive gradients in thin films (DGT), as a passive sampling method, has received increasing attention for its applications in measurements of bioavailable chemicals (both cations and anions) in soils, waters, and sediments. It has significant advantages over traditional methods: in situ measurement, time averaged concentrations and high spatial resolution. The advantages of DGT significantly promote the collection of "true" information of the bioavailable or labile forms of chemicals in the environment. This presentation provides a summary of recent development of a new DGT variant using Zr-oxide based binding gels. The Zr-oxide DGT was developed in 2010. It has relatively high capacity for measurements of oxyanions (P, As, Cr, Se, Sb, Mo and W), with 50 and 5~29 times of those of the commonly used ferrihydrite DGT for measurements of P and As, respectively. It is easy to provide high-resolution (sub-millimetre), two-dimensional spatial information of P using a gel coloration procedure, while this technique has been successfully applied to in situ monitoring labile P in a large eutrophic Lake Taihu in China. Simultaneous measurements of cations and anions, such as P and S, P and Fe, As and Fe, and As, Fe and P, have been successful achieved through development of several types of mixed binding gels based on the Zr-oxide gel. More functions are being extended with this technique for measurements of other analytes.

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08

Environmental risk assessment and remediation technologies

Sustainable remediation of contaminated soil by using Greek diasporic bauxite

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Abstract Type Oral Presentation

Abstract

The immobilization of inorganic - non degradable contaminants in soil has been suggested as a sustainable remediation method aiming in breaking the pathway between the source and the receptor in the widely used 'source- pathway-receptor' risk assessment approach. Within this framework, various mineral-based amendments can be used in raw or modified form for inducing immobilization of inorganic contaminants in soil with different modes of molecular-scale sequestration. In this study, Greek diasporic bauxite in raw form as well as after heat treatment at different temperatures (105, 350 and 450°C) was tested for its effectiveness in reducing the mobility of potentially harmful elements (PHE) in contaminated soil. A pot experiment was set up where calcined (350°C) bauxite was mixed at different proportions (0%, 1%, 2%, 4%, 5% and 7%) with contaminated soil from the sulfide ore mining area of Stratoni, North Greece. Total concentrations in soil have medians of 1000 mg/kg Pb, 712 mg/kg Zn, 184 mg/kg Cu, 6 mg/kg Cd, 296 mg/kg As and 2900 mg/kg Mn. The effectiveness of bauxite amendment was evaluated by comparing leachable PHE concentrations of treated and untreated soil after a four week period of repeated cycles of wetting and mixing. Two batch leaching tests were used, one using deionized water (EN 12457-4) and another using a weak acid solution (TCLP). Also, a comparison of stabilization efficiency was carried out between the bauxite material used in the pot experiment and bauxite treated at different temperatures for a given rate of mixing (7%). Both raw and calcined bauxite in a mixing proportion of 7% reduced leachable concentrations of the elements in comparison to the original soil. Samples that were mixed with activated bauxite at lower temperatures (105 and 350°C) and raw bauxite showed similar results. The corresponding reduction of water leachable metal fraction of PHEs was determined as high as 75% for Zn, 66% for Mn, 55% for Cd, 51% for Pb, 44% for Cu and 41% for As. TCLP extractable concentrations remained relatively low for Pb (60% reduction), Zn (30% reduction) and As (28% reduction). The maximum efficiency was observed by using treated bauxite at the temperature of 450°C with negligible water leachable concentrations after treatment. This difference in retention efficiency of elements is attributed to phase transitions that occur in Al-oxyhydroxides and Fe-oxides/oxyhydoxides of bauxite when heated at higher temperatures.

Uptake of potentially toxic metals from saline waters by living macroalgae *U. lactuca*: simultaneous removal of Hg, Pb and Cd

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Abstract Type Oral Presentation

Abstract

Nowadays, there is a global awareness about the harmful effects that potentially toxic elements such as Cd, Pb and Hg may have on human and animal health, even at very low concentrations. Thereby, environmental policies worldwide are becoming more stringent every day, especially in the water field, where for example the European Union recently prohibited the emissions, discharges or losses of Cd and Hg. The physicochemical methods, conventionally used in the removal of metals from water, present major drawbacks, do not allow compliance with the new European guidelines, or are prohibitively expensive. Seeking for alternatives, processes of biosorption and bioaccumulation have been recently studied, assessing the ability of largely available biomasses, or living organisms to bind and retain metals. However, most of works have been devoted to non-living biomass, focusing on the removal of a single contaminant in synthetic or fresh water, usually at unrealistic high concentrations of metal or biosorbent. In this work, a living marine macroalgae, Ulva lactuca, was applied for the removal of Cd, Pb and Hg from spiked seawaters, under different contamination scenarios, mimicking those found in real world. For monometallic solutions, with concentrations ranging from 10 to 1000µg/L, by using only a mass of seaweed/volume ratio of 500 mg/L (d.w.) it was possible to reduce 93 to 99% of initial metal levels, allowing to achieve the Portuguese water quality criteria for the studied metals, regarding both surface and drinking waters. The bioremediation efficiency was also proven in multi-contaminant systems, comprising simultaneously the three metals. The removal of Hg (c.a. 99%) was not significantly affected by the presence of Cd and Pb, whereas the removal of Cd and Pb varied between 57-96%, and 34-97%, respectively. Analysis of metal content in macroalgae biomass, demonstrated that all Cd and Hg removed from solution was really incorporated by the organism, while only half of Pb showed to be bound on the biomass. Overall, U. lactuca accumulated up to 209 µg/g of Hg, 347 µg/g of Cd and 1641 µg/g of Pb, which corresponds to bioaccumulation factors of 500 to 2200 (dose-dependent accumulation). U. lactuca showed different selectivity toward metals, following the sequence order: Hg > Cd > Pb. Under the full range of experimental conditions used, no mortality was observed, and the organism growth was not significantly affected. Overall, results intend to contribute for developing a new environmental biotechnology, applied for contaminated saline water, more efficient, ecofriendly, and cost-effective than conventional treatment methods.

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Macroalgae biomass for cleaning contaminated salt waters

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Abstract Type Oral Presentation

Abstract

The progressive rise in world population and the increasing need for goods and products, led to production of large amounts of effluents, with high levels of pollutants. Among pollutants, metals are a serious threat, in particular mercury, lead and cadmium, due to their toxicity and persistent character in the environment and biota as well as bioaccumulation and bioamplification along the food chain [1,2]. Thus,it is extremely important to find new strategies for the metal removal from waters. New approaches are continually being examined to supplement traditional water remediation methods. However, most of the remediation studies are intended to fresh water but salt waters are often the last receptor of pollutants. Biosorption has emerged as an area of great potential for the removal of metal ions from polluted waters, since the materials used are usually cheap, environmental friendly and very available in nature, but so far this approach has not been applied to salt waters. In this work we studied the sorption capacity of two different marine macroalgae biomass (Ulva lactuca and Fucus vesiculosus) toward mercury, lead and cadmium in salt water. Both macroalgae was used with a particle size <0.2 mm, in a mass/volume ratio of 500 mg/L. The efficiency of the macroalgae was tested for two contamination scenarios: one in which all metals are in concentrations low and equal to 50µg/L, and the other in which Hg, Cd and Pb are in concentrations that equal their maximum legal limit allowed for wastewater discharges in Portugal (Hg 50 µg/L; Cd 200 µg/L and Pb 1000 µg/L)[3]. Under the experimental conditions studied it was possible to conclude that the affinity of both biosorbents to the selected metals is in the order Hg > Pb >> Cd. Comparing both macroalgae, it is possible to observe that in general the brown algae is more efficient than the green one for Hg and Pb in salt water. For Cd, the percentage of metal removal did not exceed 10% in both algae. Globally, F. vesiculosus displayed higher initial sorption rates, higher removal percentages and higher amounts of metals sorbed than U. lactuca. Moreover, the biosorption of Hg by brown and green algae was not inhibited by the presence of Cd and Pb, even when the coexisting metals were present in higher concentrations in solution. With an efficiency of removal higher than 98% for Hg and 68-88% for Pb, both macroalgae proved to be very efficient biosorbents on reducing significantly the levels of these contaminants in a polluted salt water.

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Dusts from mining and smelting areas in northern Namibia: reactivity and contaminant bioaccessibility

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Abstract Type Oral Presentation

Abstract

Dust materials escaping from mine tailing disposal sites and smelting facilities can have direct effects on populations living close to these operations. We investigated dusts from mines and metal smelters in the northern Namibia, using a combination of mineralogical techniques in order to understand the solid speciation of the contaminants, as well as their leaching and bioaccessibility using in vitro tests in simulated gastric fluid to assess the exposure risk for humans. The leaching of metals was mainly dependent on the contaminant bulk chemistry and mineralogy. Bulk concentrations of metal(loid)s in the mine tailing materials varied in the range of hundreds to thousands of mg/kg, but the bioaccessible concentrations were very low. Slag materials contained much higher levels of contaminants (5000 mg/kg As, 2.4 wt% Pb, 6.2% Zn) and bioaccessible fractions (BAF) for these contaminants attained 43%, 49% and 29%, respectively. The highest contaminant concentrations were reported for the smelter dusts sampled near bag house flue gas cleaning system (43.7 wt% As, 4 wt% Pb, 2 wt% Zn). Being predominantly composed of soluble arsenolite (As_2O_3), smelter dusts were highly reactive and BAF values were elevated, especially for As attaining 60% of total concentration.

Based on these results, a potential risk can be recognized, particularly from ingestion of smelter dusts. Daily intakes via oral exposure, calculated for an adult (70 kg, ingestion rate 50 mg dust per day) exceeded the tolerable daily intake (TDI) limits for Pb (2.3×) and As (187×) in the case of these materials, whereas only limited risk was detected for mine tailings and slags. The workers in the smelter are protected with the masks and their exposure to As-bearing dusts is probably limited, but the safety measures should also be taken outside the factory and the risk related to the ingestion of polluted soil-derived dusts by local residents must be evaluated in the future.

Mercury pollution in the environment of Hg mining areas in Guizhou and health risk

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Abstract Type Oral Presentation

Abstract

The toxicity of methylmercury (Me-Hg) has caused widespread public human concern as a result of several widely publicized disasters. Me-Hg is highly toxic, and the nervous system is its principal target tissue for humans. Although the general population is primarily exposed to Me-Hg through contaminated fish and marine mammals, in Hg mining areas a long history of mining activities can produce serious Hg pollution to the local environment. In a study of 98 persons from the Wanshan Hg mining area, hair Me-Hg levels indicated Me-Hg exposure. Rice, the staple food of the local inhabitants also showed high total Hg (T-Hg) and Me-Hg levels. The geometric mean concentration of T-Hg and mean concentration of Me-Hg in rice samples collected from 3 villages in Wanshan Hg mining area were 36.2 (ranging from 4.9 to 214.7), and 8.5 (ranging from 1.9 to 27.6) μg/kg, respectively, which were significantly elevated compared to the rice samples collected a reference area, where the mean T-Hg and Me-Hg concentrations were 7.0 (3.2–15.1) and 2.5 (0.8–4.3) μg/kg, respectively. Pork meat, vegetable, and drinking water samples collected in Wanshan Hg mining area contained highly elevated T-Hg, but very low levels of Me-Hg. The relationships between the estimated rice Me-Hg intake and hair Me-Hg levels (r) 0.65, $p < 0.001$) confirmed rice with high Me-Hg levels indeed was the main route of Me-Hg exposure for the local residents in the Wanshan Hg mining area. From our study, we can conclude that the main human exposure to Me-Hg via food consumption is not restricted to fish, but in some cases in mining areas of China to frequent rice meals. Then we conducted a large survey in an inland area to assess exposure of THg and MeHg to general populations. We used Guizhou province as an example, as this represents a region seriously contaminated with respect to Hg in China. We selected four case study regions in Guizhou province, representing typical environments with severe pollution from Hg mining and smelting (Wanshan), traditional (recently closed) zinc smelting (Weining), heavy coal based industry (Qingzhen) and a village in a remote Nature Reserve (Leigong). The probable daily intake (PDI) of MeHg for adult population (with 60 kg body weight) was considerably higher in Wanshan than the other three places. With an average PDI of 0.096 (range of 0.015–0.45) μg/kg body weight per day (bw/day), approximately 34% of the inhabitants in Wanshan exceeded the USEPA established reference dose (RfD) of 0.1 μg/kg bw/day. The PDI of MeHg for residents in the three other regions were all well below 0.1 μg/kg bw/day (averages from 0.017 to 0.023, with maximum of 0.095 μg/kg bw/day). In all four regions, rice consumption accounted for 94–96% of the PDI of MeHg. The major finding from our study is that rice consumption is by far the most important MeHg exposure route, however, most of the populations (except those in Hg mining areas) have low PDI of MeHg.

Human body burden and dietary methylmercury intake: the relationship in a rice consuming population

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Abstract Type Oral Presentation

Abstract

Rice is the main route of methylmercury (MeHg) exposure for rice consuming populations in mercury (Hg) mining areas in Guizhou, China. But risk assessments of MeHg exposure are based on epidemiological data from fish consumption. This study was designed to evaluate the relationship between dietary MeHg intake and human body burden in a rice consuming population from the Wanshan Hg mining area, China. The MeHg concentrations in rice averaged at 12 ± 9 ng/g and the average probable daily intake (PDI) of MeHg via rice consumption in different sites ranged from 0.05 to 0.13 μg/kg-bw/d. Hair MeHg concentrations averaged at 2.1±1.8 μg/g, while the average of blood MeHg in different sites ranged from 2.2 to 9.4 μg/L. The MeHg constituted 53 ± 18% and 72 ± 18% of THg on average in blood and hair samples, respectively. Blood and hair MeHg concentrations, rather than THg, can be used as proxy of human MeHg exposure. Hair MeHg levels showed no significant monthly variation, even hair THg can be impacted by inorganic Hg exposure. The toxicokinetic model of MeHg exposure based on fish consumption underestimated human body burden, which maybe resulted from the high hair-to-blood MeHg ratio (361±105) in the rice consuming population studied here. Nutrients may impact the absorption, distribution, and elimination of MeHg in the body of rice consumers. Generally, the study population is exposed to MeHg to a certain level through rice consumption, and more attention should be given to exposure to the developing fetus.

Lead-Zinc mining and home-grown foodstuffs (Eastern FYR Macedonia)

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Abstract Type Oral Presentation

Abstract

Mining accompany our civilization since evolution. Since the "Copper (Chalcolithic) Age" and later "Golden Age", mining activities have created great wealth. Unfortunately, beside wealth the exploitation of metal rich ores, have been almost always correlated with a negative impact to the nearby ecosystems. In this study a broad area around the active Pb-Zn Sasa mine (NE FYR Macedonia) was characterized, to evaluate the contents of some Potentially Toxic Elements (PTE). The PTE were determined in the surrounding fresh waters (lake and rivers), soils and the home-grown vegetables. The evaluation of the potential hazardous effects of the PTE, especially on humans, is a key goal. The PTE's were determined by ICP-AES and ICP-MS. Furthermore also detailed questionnaires were applied among the local inhabitants. Sequential extraction analyses of selected soil samples revealed that the majority of PTE was bounded to water soluble and exchangeable fraction, which shows that those elements (Ag, As, Cd, Cu, Mo, Ni, Pb, Sb and Zn) are therefore very easily mobile and consequently available to plants. According to the applied questionnaires, the consumption of home-grown foodstuffs is high, and certain vegetables, such as tomatoes, peppers, salads, etc., are consumed every day or even more than once a day. Chemical evaluation of PTE in home-grown vegetables revealed that the most crucial PTE's (those which heavily exceed upper allowable limits) are Cd, Co, Cu, Pb and Zn, and are closely followed by Cr and As. The calculated Health Risk Index (HRI) shows extremely high estimated values, both for adults and children. As the study area is surrounded by rich metallogenic ore deposits, is expected that the natural background is slightly higher than elsewhere. Nevertheless, the concentrations of PTE's in waters used for irrigation which were increased and the wind-blown (aeorogenic) PTE's pollution from the nearby tailings dam, both increases the PTE contents in the studied foodstuffs. Thus, the health of inhabitants in this area is of high concern.

Cadmium dietary intake in women from Aveiro University (Portugal) - a duplicate diet study

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Abstract Type Oral Presentation

Abstract

Cadmium (Cd) is an environmental pollutant well known by its harmful effects towards humans, such as its carcinogenic potential. It can enter the human body either by ingestion or inhalation. Among the possible exposure sources, food is considered the most important one for the general population providing over 90% of the total intake in non-smokers. Once entering the body it can act as an endocrine disruptor able to mimic estrogens, and therefore Cd exposure may be a potential risk factor for the development of estrogen-dependent diseases in women such as endometriosis, breast and endometrial cancers. In order to assess the women exposure to this metal through diet intake, levels of Cd were quantified by ICP-MS (Inductively Coupled Plasma – Mass Spectrometry) in duplicate diet samples provided by 23 women working or studying at University of Aveiro, Portugal. The women participating in this study provided a duplicate sample of their diet during seven consecutive days while registering all the food items consumed. Additionally, all the volunteers answered a food frequency questionnaire and provided their biometric parameters. Cd was detected in all analyzed samples with concentrations ranging from 0.05 to 1.73 µg/g wet weight (median 0.08 µg/g wet weight). With the information provided by volunteers on the food items consumed the total daily amount was estimated and the most important food items described for each participant. The dietary intakes of Cd were then calculated and compared to the Tolerable Weekly Intake set by the European Food Safety Agency (2.5 µg/kg body weight/week), and the associated risk was addressed.

Arsenic and heavy metals assimilation by corn grown near tailings

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Abstract Type Oral Presentation

Abstract

Zimapán district in Hidalgo State, Mexico, is known for the practice of mining. This area presents social and environmental problems resulting from the accumulation of tailings generated during mining operations that contain potentially toxic elements. One of them is related with arsenic and heavy metals enrichment of soils close to tailings that may be bioavailable and affect the local crops growth. This study evaluates the growth and development of corn plants (Zea mays) grown in soils impacted by mining wastes (tailings), and presents an analysis of As Cd, Fe, Pb and Zn assimilation in plant tissue, at 28 and 50 days growth. The area is situated near San Francisco tailings dam. Soil samples were collected at two different points in a cornfield near mine tailings (approximately 30 m), a control soil was sampled in a non-mineralized and non-impacted area to obtain background values, which was considered as a blank (control). Physicochemical characterization of the soil was also carried out; the highest concentrations were 641 mg As/kg, 7 mg Cd/kg, 31,500 mg Fe/kg, 610 mg Pb/kg and 938 mg Zn/kg. Arsenic and Pb concentrations exceeded the maximum permissible limits (22 mg/kg and 400 mg/kg, respectively) established by Mexican guidelines for agricultural land use. Viability and germination tests for seed, according to protocols established by the OECD, were performed. Subsequently, the experiment was conducted in rhizotrons with capacity of 500 g and 7 kg in the 28 and 50 days trials respectively, under controlled greenhouse conditions, with 3 replicates for blanks and 10 replicates for polluted soil. At the end of the growth period, plants were removed and biomass generation and length was determined; later chemical analysis of aerial part (stem and leaves) and roots were performed. Iron and Zn were the elements with greater assimilation in plants. After 28 days growth, concentration ranges in roots ranged from 533 to 3690 mg/kg of Fe and from 50 to 632 mg/kg of Zn; in the aerial parts the ranges were from 37 to 58 mg/kg for Fe and from 36 to 128 mg/kg for Zn. At 50 days growth, the Fe content in the roots ranged from 563 to 1566 mg/kg, and that of Zn between 40 and 378 mg/kg, while in the leaves, Fe varied from 43 to 93.1 mg/kg, and Zn from 27.4 to 86.6 mg/kg. With respect to As and other analyzed metals, maximum concentrations found for the root, stems and leaves were respectively 138 mg As/kg, 2.1 mg As/kg and 1.1 mg As/kg, 5.6 mg Cd/kg, 1.7 mg Cd/kg and 1.3 mg Cd/kg, 89.9 mg Pb/kg, 2.4 mg Pb/kg and 5.0 mg Pb/kg. Bioaccumulation (BAF), bioconcentration (BCF) and translocation (TF) factors were generally low; however, some had values over 1, showing the translocation of metals to the aerial parts. Inhibition was present on plants growth up to 33% compared with the control and confirmed that the content of As and heavy metals in plant tissues exceeded in all cases the "normal" values and that the concentrations found were phytotoxic.

Viticulture activity in Douro region: potential risks to the environment

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Abstract Type Oral Presentation

Abstract

Soil performs multiple ecosystem services and therefore its ecological functions have been recognized as fundamental for sustainability. Intensive agricultural activity may negatively affect soil functions due to point and diffuse contamination such as application of agrochemicals. Areas such as Douro vineyard region (Portugal), with vineyards frequently located on steep slopes of narrow valleys due to its topography, can be particularly sensitive since runoff and erosion processes are expected to enhance the transport of pollutants and act as a potential source of contamination to freshwater systems. Moreover, the quality of grapes and wine produced depends on the quality of soils. A research project (DVINE) has been carried out in order to evaluate the impact of viticulture activity on the quality of soils and also on the adjacent aquatic systems. The potential risks to the environment due to the use of agrochemicals and management practices in vineyards were also evaluated. The study was conducted in a region draining to tributaries of Douro River, which are joined into a dam reservoir, where sediment and surface water samples were collected. The strategy for soil sampling included the collection of composite samples from different terraces in three areas according to vineyards age: less than 15 years, between 15 and 50 years, and more than 50 years. The geochemistry of vineyards soils, sediment and surface water (metals, nutrients and general properties) was assessed, as well as the levels of selected pesticides in the same matrixes. The pesticides under analysis were selected according to a survey of the most important and commonly applied to the vineyards of the region and they include fungicides (cymoxanil, boscalid, folpet, metalaxyl, penconazole), herbicides (glyphosate, terbutylazine), and insecticides (chlorpyriphos, deltamethrin). Some pesticides currently banned were also included because they are considered priority substances under the scope of Water Framework Directive (endosulphan, DDT, and simazine). Levels found in the water compartment (both water and sediments) were in general low, for both inorganic and organic contaminants, especially in water samples. These low levels of pesticides found in water samples suggest that wine-growing might not have a negative impact on the quality of surface waters of the site under study. Yet, the monitoring of pesticide levels, especially in water, should be conducted in different seasons and particularly during the peaks of seasonal application of pesticides. Residues of several pesticides and inorganic contaminants related to agricultural activities were found in soils, with older vineyards showing higher levels of banned insecticides (such as DDT) and Cu. Potential risks to the environment were calculated based on existing models and considering the effect of the mixture of contaminants.

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Limestone as a sustainable remediation option for groundwater polluted with fluoride

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Abstract Type Oral Presentation

Abstract

Groundwater pollution with fluoride is a worldwide problem since water is the main source of Human chronic exposure. An excess of fluoride causes health effects as dental or skeletal fluorosis. In Mexico, the presence of high amount of fluoride in the groundwater this is a major concern since about 75% drinking water comes from groundwater supply and about 4 million people live in areas enriched in fluoride. Removal of fluoride requires specific methods, many of them involving expensive installations and/or operation. Limestones formations, which are abundant in the Mexican territory, have been proved effective to remove arsenic from polluted waters. We have evaluated the usefulness of this geologic material as a sustainable and economic option to remove fluoride dissolved in the groundwater through batch and column experiments. Batch tests were performed with different fluoride concentrations (2, 3, 4 mg/L), which are above the WHO guideline (1.5 mg/L), pH values (within ranges measured in Mexican polluted groundwater), and different rock particle sizes. Maximum removal efficiencies were among 70-80% and were dependent on experimental conditions. A similar efficiency was reached in columns experiments. However, it decreased gradually along 10 weeks of operation reaching non-significant removal. Influence of sulfate as a possible interfering anion, common in natural waters, in the removal efficiency was also evaluated in batch and column experiments. Adsorption isotherms and geochemical modeling indicated Freundlich adsorption or precipitation prevalence depending on the $F^-/CaCO_3$ ratio. Preliminary results showed that limestone is a promising material to obtain safe drinking water at polluted sites, but sulfate concentrations should be considered since it may decrease removal percentage.

MEDGEO'15

poster

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08

Environmental risk assessment and remediation technologies

Exposure to nephrotoxic pollutants in Las Brisas community (El Salvador)

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Abstract Type Poster

Abstract

Globally, especially in the developing countries, the existence of stocks of obsolete, banned and highly toxic pesticides is a serious problem for environment and human health. Recently, in El Salvador, have come to light in national media several cases of former infrastructures where pesticides were manufactured and/or stored. Nowadays, most of these chemical products are obsolete and banned in El Salvador. One such case is the former formulator pesticide factory AGROJELL S.A. de C.V., located in the municipality of San Miguel, one of the most important cities of El Salvador. The city is on a plain to the NE of the active volcano known as Chaparrastique and west of Rio Grande de San Miguel one of the major rivers of the country in whose basin are former mining areas. Around the factory AGROJELL S.A. de C.V., there is Las Brisas community, a suburban neighbourhood of high social vulnerability located near the Rio Grande de San Miguel. In 2010, Salvadoran Environmental Ministry withdrew 92 barrels of toxaphene and other dangerous chemicals from the ruins of this factory. This chemical warehouse was abandoned since the 80s and was partially dismantled by the people who inhabit the area.

Las Brisas community has a high prevalence of chronic kidney disease nontraditional cause (CKDnt), whose main risk factors are related to the exposure to toxic pesticides enriched in heavy metals that affects Salvadoran agricultural communities.

Arsenic and Paraquat contamination in surface and groundwater from Las Brisas community and surrounding areas were found by the present study. This is even more worrying since some families do not have water service and are only supplied by shallow wells. Arsenic pollution could have geogenic (hydrothermal or volcanic material enriched in this element) and/or anthropogenic origin (as former mining production, urban and industrial waste). Paraquat is the most widely used pesticide in El Salvador, most likely associated with corn crops.

Arsenic, Paraquat and Toxaphene are nephrotoxic substances. Thus, Las Brisas population has been exposed to a nephrotoxic load from different sources. This chronic exposure can be the explanation of the high prevalence of CKDnt of Las Brisas community, whose inhabitants, in general, are not related to agriculture activities.

Methodological approaches to derive Soil Screening Values for U, Cd and Cu for Portuguese Natural Soils

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Abstract Type Poster

Abstract

Ecotoxicological data for uranium (U), cadmium (Cd) and copper (Cu) were obtained for soil invertebrates, plants and for soil microbial parameters, following standard protocols and well known protocols from the literature. The obtained sensitivity values (EC20 and EC50s) were used to derive generic soil screening values (SSVs) for these metals. The SSVs were derived following the species sensitive distribution (SSD) approach and HCp values (HC5 or HC50) for each metal were estimated. The selection of the best HCp to support the derivation of SSVs was discussed, based on the statistical confidence of the estimations and the data points in left side of the curves, below the HCps selected. Estimated HCp were also compared with available data for field and laboratorial studies with Portuguese natural contaminated soils. All the criteria were taken into account to support expert judgment aimed in preventing the selection of over-protective HCp values. The, following SSVs were proposed: uranium 151.4 mg U/kg (dw), cadmium 5.6 mg Cd/kg (dw), and copper 58.5 mg Cu/kg (dw) for Portuguese natural soils similar to the one tested in this study. A comparative analysis with other European and international soil quality guideline values was made. The present work represents an important contribution for setting a national approach for deriving soil screening values for a generic use, for the environmental risk assessment of contaminated areas. The approach proposed will take benefit from the tools and methodologies developed by other European countries with great expertise in the area, thus contributing for the harmonization of procedures within Europe.

Tracking enteric viruses inactivation by gamma radiation in aquatic environments

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Abstract Type Poster

Abstract

Enteric viruses are human pathogens that primarily infect the intestinal tract through ingestion of contaminated water or food. These viruses can enter the environment through the discharge of waste materials from infected individuals and contaminate aquatic environments. Norovirus (NoV) and Adenovirus (AdV) are a worldwide environmental threat, being part of the major enterically non-bacterial transmitted agents. NoV and AdV are directly related with viral waterborne outbreaks attributed to contaminated water consumption or exposure to recreational waters. Wastewater treatment processes only eliminate part of the viral load, letting a substantial fraction to be released in effluent discharge. The stability of enteric viruses and their presence in environmental waters cause serious implications on public health. In this scenario gamma irradiation could be an important technology to achieve elimination of viral waterborne pathogens. The main goal of this study was to investigate the inactivation patterns of murine norovirus (MNV^{-1}), as a NoV surrogate, and human adenovirus type 5 (AdV-5) by gamma irradiation. Six different substrates – PBS (phosphate buffered saline), pure water, tap water, FBS (fetal bovine serum) and aqueous solutions of 10% and 50% FBS, were inoculated with known concentrations of MNV and AdV and irradiated in a Co-60 source at several doses (from 1 up to 10 kGy). The inactivation of viral particles was tested by plaque assay using Raw 264.7 and A549 cells. The D10 values (dose required to reduce the virus by 90%) were estimated for each virus and substrate. The results indicated that MNV and AdV were susceptible to gamma irradiation but the viral resistance was influenced by the substrate. A reduction on MNV and AdV titers of 4 $\log_{10}$ PFU/ml (99.99% inactivation efficiency) was achieved after irradiation at 3 kGy on PBS, tap and pure water suspensions. However, MNV and AdV were approximately 3 times more resistance to gamma irradiation when irradiated in FBS suspensions, and even at a dose of 10 kGy it was detected the presence of viral particles in an infective state. The observed D10 values ranged between 0.76 kGy (pure water) and 3.15 kGy (FBS) for MNV; and between 0.87 kGy (PBS) and 2.94 kGy (FBS) for AdV. These results highlight the substrate effect on the inactivation of MNV and AdV by gamma radiation. Highly proteic matrixes seem to protect the viral particle from the effects of gamma radiation. In opposition, in water or aqueous solutions viral radioresistance seems to be significantly weakened. The study of the MNV and AdV inactivation patterns on different substrates will open new insights on the virucidal mechanisms of gamma irradiation, with the outcome of safe and unique applications of inactivated/attenuated virus. Moreover, this work will introduce new concepts to re-inforce the benefits of radiation technologies as an effective mitigation tool.

Radioactivity monitoring and reduction of radiation exposure at legacy uranium sites in Portugal

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Abstract Type Poster

Abstract

Uranium legacy sites in Portugal include large amounts of milling tailings, mining waste, old infrastructures and acid mine drainage with high radioactivity concentrations. This legacy was considered a public health risk and a threat to environment and the Government approved a remediation plan to ensure radiation protection at those sites. One amongst such sites, the Urgeiriça mine and milling site (Viseu), was re-engineered, tailings were covered, the mine was closed, the area of mine and milling facilities cleaned, and an automated contaminated water treatment plant installed. Environmental radioactivity surveys carried out in this region over the years showed decreasing ambient radiation doses, lower radon concentrations in surface air, return to background radioactivity in surface air aerosols, and decrease of radionuclide concentrations in the river receiving water discharges from the mine site, resulting in a reduced radiation exposure to members of the public. Other legacy uranium mines without milling tailings, were mainly remediated for landscape engineering and the solutions adopted included, for example, preservation of non-contaminated ponds for public leisure. Although not completed yet in many old uranium mine sites, the remediation works implemented contributed already to a significant abatement of radiation exposure allowing for safer implementation of economic activities, such as agriculture and cattle grazing in the surroundings of legacy sites. Environmental remediation and abatement of radiation exposure contributed to revitalize socio economic activities of the region.

Phytoremediation using *Brassica juncea* – a case of Krugersdorp mine tailings and neighbouring soils

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Abstract Type Poster

Abstract

Imbalances of minerals in mining tailings and adjacent soils threaten all biodiversity that depend on them. The uptake and metabolic interactions of both nutritional- and potentially harmful elements (PHEs) by plants can bring about deficiencies or toxicity symptoms depending on the nature of the biophysicochemical interactions. Due to the serious environmental health concern posed by contaminated soil from mining activities, research on phytoremediation techniques is intensifying, to determine cost effectiveness, environmentally friendliness as well as other possible merits in mitigating the effects of heavy metal-contaminated soils. This study used Brassica juncea in combination with organic supplements grown in contaminated soil to establish a potential ex situ phytoremediation technique. Tailings from Mintails Gold Mines in Krugersdorp (KS7B1), South Africa, and soils from a nearby Private Farmland (KS4B) and Game Reserve (KS3A1) were sampled. Aqua regia digestion and ICP-MS analysis were used to determine both heavy metals and nutritional elements present in the soil samples. In a greenhouse experiment, Brassica juncea seedlings were treated (20 ml, soil drenched) once a week for four weeks with three biostimulants: Kelpak® (0.4%), vermicomposting leachate (1:10 v/v) and smoke-water (1:500 v/v). Indole-3-butyric acid (IBA 10-5 M) was included as a standard rooting hormone while water served as the control. Seedlings did not survive in KS7B1 with the various treatments due to high concentrations of heavy metals. Brassica juncea grown on KS4B and KS3A1 soil samples treated with Kelpak® and vermicompost leachate showed an increase in various growth parameters compared to the IBA treatment and controls. Overall, Kelpak® treatment had the best stimulatory effect. Analysis of heavy metals accumulated in plant material is in progress and these later results will elucidate the stimulatory effects of the tested biostimulants in the uptake of heavy metals. This could be a vital tool in the practical application of remediation of heavy metal contaminated sites.

Mineralogical associations of arsenic and heavy metals in a limestone-based AMD treatment system

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Abstract Type Poster

Abstract

Acid mine drainage (AMD) is widely known for its high content of heavy metals, arsenic, acid pH, and for causing harm to biotic and abiotic factors of ecosystems. Given this, limestone systems have been an ecologically and economically feasible option for AMD mitigation. During AMD treatment in a limestone-based system, physicochemical changes occurring in the system result on the stabilization of toxics by precipitation and sorption. The long-term effectiveness of these treatments depends on the mineralogical associations that elements form. In this study, the mineralogical characterization of solids formed during an AMD treatment with limestone is reported; AMD was obtained from a tailings heap with advanced weathering processes. Solid samples were analyzed by conventional techniques such as XRD, SEM-EDS, SEM-WDS and FTIR-ATR. XRD results showed the formation of gypsum ($CaSO_4 \cdot 2H_2O$), schwermannite ($Fe_8O_8(OH)_6(SO_4) \cdot nH_2O$) and ferrihydrite ($Fe(OH)_3$)am; whereas analyses by SEM-EDS and SEM-WDS showed mineralogical associations between the following elements As/Fe, As/Fe/Zn, Zn/Ca, Al/SiO_2/K. Surface passivation of some limestone particles was observed, mainly by the presence of compounds rich in aluminum, iron and calcium. The first layer was conformed mostly by aluminum compounds, the intermediate layer by iron compounds and the outermost by calcium compounds. Precipitation of aluminum before iron compounds was probably related to a kinetic factor. The FTIR-ATR analysis suggests adsorption of As on the produced ferric hydroxides; this kind of adsorption has been reported as chemisorption, so this element is stabilized in the system. In contrast, some solutions obtained at the end of the treatment showed variations in the concentration of Zn, probably due to a Zn/$CaCO_3$ association which has been reported to be unstable, implying that Zn is only temporarily stabilized. Results suggest that these systems are efficient for stabilizing As, Fe and Al and could be applied in-situ for AMD mitigation; however, further studies focused on the removal and stabilization of Zn are required.

Uranium mining production: cause of eye pathology

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Abstract Type Poster

Abstract

The intensity of geological prospecting works and mining production for uranium are currently reduced. This has been a temporary phenomena caused with the fall in uranium prices. It is supposed that six atomic power stations will be launched in the world in the nearest future. Strengthening of works for uranium induce to seek the ways for reducing of their impact on nature and human health. According to data of ophthalmologists radiation exposure affects all parts of the eye. Professional defeat of radiation could have been at all stages of atomic energetic: mining operations, uranium ore processing and works with fuel elements, storage and disposal of nuclear wastes as well as transportation of nuclear wastes. Eye pathology in varying degree of severity appears in 5-10 and more years at professionals worked at uranium mining and processing industry and especially aggravated in age categories of fifty years and more. Natural and technological sources affect the environment. The main types of impact are produced by technological processes and nuclear production wastes. Under the impact means such functional manifestations of the above mentioned sources which change the status of natural environment and projected status of the objects of technological system. Uranium mining operations are closely connected with peculiarities of general mining profile and with characteristics of useful component of the ore – uranium. There are two peculiarities in uranium mining operations: radioactivity and geotechnology technique – "in situ leaching". The monitoring of different types of impact puts into effect by using of indicators. In each specific case you need a failsafe way of identifying the representative indicator. Under the representative indicators mean indices prominent to the substance of sources of impact or processes initiated by them. Geological factors pose a risk of developing certain eye defects, and the origins of these risks can be divided into three main categories. As exploration and mining of uranium deposits continues, understanding these risks is of utmost importance in order to maintain the health of the population. Objective monitoring of the geological environment is the most purposeful and appropriate way to conduct the environmental research. Measures of environmental protection, during the course of the exploration and mining of uranium, should be carried out at all stages of exploration, development, mining, and rehabilitation of the uranium-mining territories. Specific methods in this area will help improve the health and quality of life of the people at risk.

Recovery and separation of heavy metals (cadmium, lead and zinc) contained in the wastewaters using by liquid membrane process

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Abstract Type Poster

Abstract

The discharge of toxic metals into environment is a serious problem facing numerous industries. So this paper presents an experimental investigation for simultaneous extraction and recovery of harmful heavy metals from the industrial wastewater through liquid membrane non supported (LMNS) based technology. The selective separation and recovery are achieved by the transportation through liquid membrane has shown great interest in this way especially in cases where metal concentrations are relatively low of the such heavy metals. The oxide tri-n-octyl phosphine (TOPO) as the extractant is dissolved in kerosene is the organic phase which function as a non-supported liquid membrane. The performance of the liquid membrane method, it can be improved to a large extent by using a suitable extraction agent such as carrier. The effects of various physico-chemical parameters, such as pH of feed phase, concentrations of feed phase, reextraction phase and concentration of the carrier , on the extraction of only cadmium, lead and zinc are studied initially in two phase equilibrium studies to determine the parameters giving the extraction efficiency and reextraction optimum. Some performances have been gotten so much to the level of the extraction that of the reextraction. The coupling that makes itself thanks to the membrane (extractant + diluent) permits to define the different phases of transfer and to determine the mechanisms of transportation. The membrane can work thanks to the « activation » by the cosolute of the transportor at one interface and to the « desactivation » at other interface, both of these mechanisms of the active transport creating a real "chemical agitation". The results obtained highlighted the feasibility of the process by liquid membrane and the performances of the coupling. This lets predict an industrial application of the process and to hope for broad applications as well in the field of metalliferous processing liquid waste not very in charge as in that of the industrial wastes, technological and economic point of view

Effects of nano-cobalt oxide in soil species

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Abstract Type Poster

Abstract

In the last decade, metallic nanomaterials (NMs) displayed outstanding properties and applications in different fields like chemistry, optics, magnetism, electricity which in turn have contributed for their current exploitation and applications in catalysis, electronics, coatings and biomedical developments. Magnetic NMs like iron, nickel and cobalt have shown big interest in the areas of medicine, biotechnology, drug delivery, hyperthermic cancer treatment and medical imaging. Moreover, cobalt oxide NMs (n-Co_3O_4), in particular, are currently attracting enormous interest owing to their unique size-and shape-dependent properties and potential applications in, for example, pigments, catalysis, sensors, electrochemistry, magnetism, energy storage, etc. Furthermore, n-Co_3O_4 has been widely studied for its application in lithium ion battery electrodes; it has been also investigated extensively as promising materials in gas-sensing and solar energy absorption and as an effective catalyst in environmental purification and chemical engineering. Considering the increased production and applications of synthetic NMs, assessing their safety has become a worldwide issue. Nevertheless, there is a few data and experience on environmental hazard evaluation of cobalt oxide NMs. In contrary, the hazard assessment in terrestrial ecosystem stills lacking. For this purpose, a battery of sub-lethal ecotoxicological tests was performed to assess the influence of n-Co_3O_4 on soil plants germination and growth and on avoidance and reproduction of invertebrates Eisenia andrei and Folsomia candida. For this purpose, the standard artificial soil OECD (5% of organic matter) was spiked with aqueous suspensions of n-Co_3O_4 before testing. The same suspensions were characterized by light scattering techniques. The data registered showed significant inhibition in the growth of Z. mays at concentration up to 769.2 mg/kg soildw n-Co_3O_4. Concerning the terrestrial invertebrates, the results showed significant avoidance ($p < 0.05$) of E. andrei earthworms at the highest concentration tested (1000 mg/kg soil dw n-Co_3O_4), while significant ecotoxicological effects on springtails F. candida ($F = 8.043$, d.f 1 = 20, d.f 2 = 26, $p = 0$) reproduction was recorded for all tested concentration.

Chemical forms of Zn in the surface sediments of Mero river (NW Spain) and ecological risk assessment

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Abstract Type Poster

Abstract

Metals are widely dispersed in the aquatic environment, and ultimately deposit in the sediment, which is therefore of particular interest concerning its metal content. Metal mobility and bioavailability is determined by the total metal concentration and by its geochemical forms. The knowledge about metal fractionation among different sediment phases is particularly important to assess the potentially bioavailable fractions and any risks to human health. The objective of this study was to investigate the total content and distribution of Zn in bed sediments collected from the upper Mero River (NW Spain), which drains a rural catchment with agroforestry land use, with the purposes of defining Zn fractionation in the solid phase of sediments and predicting Zn ability of being released to the environment. Four surface sediment samples (5 cm depth) were taken along the riverbed (including catchment headwater and outlet). Total Zn concentrations were determined after an acid digestion. Zn distribution in selected sediment samples was obtained using a six-stage sequential extraction procedure with the following reagents: ammonium acetate, hydroxylamine hydrochloride, ammonium oxalate in darkness, hydrogen peroxide, ammonium oxalate under ultraviolet radiation and acid digestion. Zn was measured by atomic absorption spectrometry. The Zn total content varied between 83.3 mg/kg in the headwater point and 64.7 mg/kg at the third point. The Zn content in the six fractions followed the same order of abundance along the river: residual > crystalline oxides of Fe > exchangeable ≈ amorphous oxides of Fe > amorphous oxides of Mn > organically bound (under limit detection). The Zn associated with the residual fraction can only be mobilized as a result of weathering, and thereby it can only cause long-term effects. The headwater point presented the higher total Zn concentration as well as the largest proportion of residual phase (75%). The labile fractions (exchangeable and amorphous oxides) increase from 14% in the headwater to 24% at the catchment outlet. The ecological risk due to the Zn concentrations was evaluated using the sediment quality guidelines (ERL: Effects Range-Low; ERM: Effects Range-Median). All sediment samples fell below ERL values (120 mg/kg), thus suggesting the low probability of ecological risk due to Zn concentrations in Mero River. However, the differences between sample points revealed the need to monitor the bed sediments quality due to changes in bioavailability produced by erosion, agricultural and livestock activities even in low altered environments.

The nature and articulation of ethical codes on tailings management in South Africa

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Abstract Type Poster

Abstract

It is well recognized that the mining industry in South Africa is highly rated for its substantial contribution to the country's economy. It is also well known that mining and ore processing activities pose a severe threat to public health and environmental well-being, in the way operations are carried out, in the way mine wastes are disposed of (in dumps), in the way local communities are relocated, and in the way mine management and the mining community in general, perceive established environmental standards and etiquette. This paper examines ethical practices and norms in the South African mining industry, with particular reference to the management of mine dumps. We analyze the modes of articulation of the country's regulatory instruments for tailings management, and review the Corporate Social Responsibility (CSR) approach of leading mining companies. Despite decades of research and resulting recommendations on tailings management, the level of adherence to environmental regulations and statutes by mine management and the mining community are shown to be at a low ebb, and the mechanisms for compliance monitoring remain weak. New perspectives on legislative issues for unsolved problems in tailings handling are put forward, and directions for future research indicated.

Impact of an organic nanovesicle in soils

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Abstract Type Poster

Abstract

Nanomaterials are increasingly meaningful products used by the society. Nanomaterials are used in healthcare, electronics, cosmetics and other areas justifying the need of specialised risk assessments to understand their potential risks to the environment and human health. Aimed in contributing with new insights about the effects of NMs to the terrestrial ecosystem, this study evaluated the effects of organic nanovesicles of sodium dodecyl sulphate/didodecyl dimethylammonium bromide (SDS/DDAB) on plants growth, and avoidance and reproduction of terrestrial invertebrates. For this purpose several ecotoxicological assays were performed with different species (Zea mays, Avena sativa, Brassica oleracea and Lycopersicon esculentum, Eisenia andrei, Folsomia candida, Echytraeus crypticus and Hypoaspis aculeifer). A wide range of concentrations of SDS/DDAB were tested, following standard protocols, and using the standard OECD soil as test substrate (5% of organic matter). The aqueous suspensions of SDS/DDAB used to spike the soils were characterized by light scattering techniques for hydrodynamic size of the vesicles, aggregation index, polydispersity index, zeta potential and surface charge. The gathered results showed that nanovesicles of SDS/DDAB were phytotoxic only for B. oleracea at concentrations above 375 mg/kg dw. F. candida reproduction was affected only when these organisms were exposed to the highest tested concentrations of SDS/DDAB (800 and 1000 mg/kg dw). Earthworms reproduction was not inhibited; however, they avoided the soil contaminated with SDS/DDAB. The results gathered in this study allowed us to infer about the ecotoxicological effects of SDS/DDAB on soil invertebrates, giving rise to data that could be used in the determination of risk limits for this NM.

Ecological risk assessment in an abandoned coal mine area: Tier I screening stage in S. Pedro da Cova mine, Gondomar, Porto

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Abstract Type Poster

Abstract

Coal mining is one of the many anthropogenic activities, which should be considered both before and after deactivation because of the potential impacts in the surrounding environment as, for example: devastation of vegetation cover, changes in soil physical and chemical structure, in soil biological composition and contamination of surface and groundwater resources. Beyond that, some heap sites are also used to dump large amounts of waste material increasing the possibilities of both, environmental and human health risks. With a great focus on the wastes from extractive industries, and aimed at attaining such objective the European Directive 2006/21/EC (EC, 2006) in the article 20 established that: "each member country should drawn an inventory of the abandoned waste facilities within their territories, which have the potential to cause negative impacts on human health and the environment". Thus, according to article 21, appropriate methodologies like risk assessment procedures should be followed. This investigation was performed to apply the Dutch framework for the risk assessment of contaminated sites to S. Pedro da Cova coal abandoned mine area, performing the first tier of the evaluation process (Tier 1), integrating both, the chemical and the ecotoxicological lines of evidence. For such purpose soil samples were collected in three different transects defined in the area. Physical and chemical parameters of soils (pH, % organic matter, water holding capacity, conductivity and total metal contents) were assessed, followed by ecotoxicological assays performed with the whole soil matrix and with soil elutriates. The results of the risk integration confirmed that the toxic effect was most likely caused by numerous factors as physicochemical features and high metal concentrations. Risk characterization indicated the existence of risks especially located in the south and north part of the heap. However, a great difference was recorded between the risks calculated based on the chemical and the ecotoxicological line of evidence, thus further investigation to Tier 2 is needed.

Heavy metal levels in seafood and health risk assessment based on its consumption in villagers of Aratu bay, Bahia, Brazil

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Abstract Type Poster

Abstract

Estuarine communities, like Santa Luzia village, located at the border of Aratu Bay, part of the Todos os Santos Bay (State of Bahia, Brazil), the second largest Bay of the world and home of the largest petrochemical complex, in the southern hemisphere, and several industrial activities are potentially exposed to environmental contaminants. Seafood consumption (fish, mollusk and crustacean) could represent a considerable risk to the community health. The objectives of this study were to evaluate the heavy metal (Hg, Cd and Pb) concentrations in several seafood (fish, mollusk and crustacean) and perform a risk assessment approach based on individual food frequency consumption of volunteers of Santa Luzia village. From December 2013 to November 2014, ready to market seafood, 1.0 kg of each (fish pititinga (Lile piquitinga) and small green eel (Gobionellus oceanicus); mollusks: mussel (Mytella guyanensis) and oyster (Crassostrea rhizophorae); crustecean white shrimp (Litopenaeus schmitti) and blue crab (Callinectes sapidus)) were purchased bimonthly from a local artisanal producer. Samples were transported to the laboratory refrigerated and stored in the freezer until processing. After thorough homogenization, an aliquot was lyophilized and grounded in a mortar. After acid digestion, the samples were subsequently submitted to analysis by electrothermal atomic absorption spectrometry (EAAS) for Cd and Pb and by cold vapor AAS for Hg. For quality control purposes, standard reference material oyster tissue (NIST 1566b) and reagent blank were analyzed in each batch. The average annual concentrations (μg/g) of Cd were 0.0014 (±0.0003) in fish, 0.010 (±0.01) in crustacean and 0.83 (±0.47) in mollusks. Lead levels were 0.04 (±0.02) in fish, 0.03 (±0.01) in crustacean and 0.22 (±0.05) in mollusks. Mercury average levels were 0.056 (±0.003) in fish, 0.11 (±0.03) in crustacean and 0.09 (±0.01) in mollusks. All values were found in accordance with the Brazilian health guidelines, being below the maximum limits required. Based on the seafood consumption of this community, evaluated by the food frequency questionnaire (FFQ), it was calculate an estimate of the noncarcinogenic risk quotient (THQ). Among the 55 individuals of this community (96% were women) interviewed, 18.2 % reported consuming some kind of seafood at least once a year; 43.6 % at least once a month; 61.8 % at least once a week and 3.6 % daily. It was found that 41.8 % of the subjects had an estimate of the risk ratio (THQ) classified as negligible (THQ < 1); 54.6 % as low risk (THQ ≥ 1 to < 19.9) and 3.6 % as high risk (THQ ≥ 20 to < 99.9). This data is important to inform the community through communication strategies of the imminent exposure risk, with the purpose to minimize exposure and consequently the health effects associated with it.

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