NOTICE - COST Action TD1407

WORKSHOP ON TECHNOLOGY CRITICAL ELEMENTS IN ECOSYSTEM AND HUMAN HEALTH

Tallinn, Estonia · 19-20 April, 2018

NATIONAL INSTITUTE OF CHEMICAL PHYSICS AND BIOPHYSICS

BOOK OF ABSTRACTS



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General Information

The workshop was focussed on Technology Critical Elements (TCEs), including the Platinum Group Metals (PGM), Rare Earth Elements (REE), as well as Nb, Ta, Ga, In, TI, Ge and Te, which are increasingly exploited and emitted due to their use in new technologies in the fields of communication, mobility and energy.

The workshop addresses the current status of knowledge to identify existing priority gaps and discuss perspective for future research. The 2 days program was articulated in podium and poster sessions presenting available knowledge on:

- exposure characterisation, including exposure pathways, from environment to humans.
- (eco)- toxicology including forms, species, mixtures and bioavailability.
- toxic effects/endpoints at all organisational levels: cell, tissue/organ, individual, community, ecosystem.
- toxico-kinetics: uptake, distribution, metabolism, elimination, bioaccumulation, detoxification.
- predictive modelling and markers in humans, animals and/or the environment.
- environmental risks, including food chains.
- potential human health risks, including sensitive/vulnerable population sub-groups.

COST Action TD 1407

Workshop on Technology Critical Elements in Ecosystem and Human Health

National Institute of Chemical Physics and Biophysics, Tallinn, Estonia 19-20 April 2018

(updated 04.04.2018)

Program

Wednesday, 18 April

Arrival at Tallinn and Check-in.

Thursday, 19 April

8:30-9:00 Registration

9:00-9:10 Opening. Urmas Nagel

9:10-9:20 Introduction to NOTICE-COST action and Training School. Antonio Cobelo-García

Session 1: TCE exposure and bioaccumulation. Chair: Sonja Zimmermann

- 9:20-9:50 KEY-NOTE: Experimental setup of TCE exposure experiments: critical considerations for kinetically-hindered elements . *Antonio Cobelo-García*
- 9:50-10:10 Electrochemical methods of Pd determination at trace level. *Monika Sadowska*
- **10:10-10:30** Additional characterization of the Danube sediments in Serbia including some TCEs. *Tatjana Trtić-Petrović*

*** Coffee-Break ***

Session 1: TCE exposure and bioaccumulation. Chair: Kevin Francesconi

- **11:00-11:20** Milk and dairy products authentification based on their isotopic and elemental profile. *Dana Alina Magdas*
- 11:20-11:40 Rare earth elements (REE) transport from soil to olive and olive oil. Nevenka Mikac

11:40-12:00 Poster flash presentations.

12:00-12:30 Poster Session.

*** Lunch-Break ***

Session 1: TCE exposure and bioaccumulation. Chair: Laure Giamberini

- **13:30-13:50** Time-Series (1991-2014) Trends of Technology-Critical Elements Accumulation in Mussels from an Urban Coastal Area (Vigo Ria, NW Iberian Peninsula). *Patricia Neira del Río*
- **13:50-14:10** Platinum accumulation in marine organisms outcomes from an exposure experiment and field observations. *Melina Abdou*







- **14:10-14:30** Effect of humic substances on the behavior of palladium in water and its bioaccumulation by Zebra mussels. *Noelia Estévez-Calvar*
- 14:30-14:50 Toxicokinetics of Gd and Gd-Lu mixture in Daphnia magna. Marge Muna

*** Coffee-Break ***

- Session 1: TCE exposure and bioaccumulation. Chair: Antonio Cobelo-García
- **15:20-15:40** Increasing levels of Technology-Critical Elements (TCE) by mining activities: exposure to living organisms in estuarine sediments. *Carlos Ruiz Cánovas*
- **15:40-16:00** Are lanthanide mining exploitations a source of environmental toxicity? *Ana Romero Freira*
- 16:00-16:20 Discussion of Session 1: Gaps, future research needs. Chairs: Antonio Cobelo-García, Laure Giamberini, Kevin Francesconi and Sonja Zimmermann
- 19.00 Dinner.

Friday, 20 April

Session 2: Ecotoxicological effects of TCE. Chair: Sonja Zimmermann

- 9:00-9:30 KEY-NOTE: New trends in invertebrate ecotoxicological testing applied to nanomaterials. *Arno Gutleb*
- **9:30-9:50** Environmental risks of nanomaterials, their toxicity and methods of determination. *Beata Godlewska-Żyłkiewicz*
- **9:50-10:10** Multibiomarker assessment of cross effects of salinity and cerium nanomaterials on the freshwater bivalve *Corbicula fluminea*. *Laure Giamberini*

*** Coffee-Break ***

Session 2: Ecotoxicological effects of TCE. Chair: Laure Giamberini

- **10:40-11:00** Genome-wide analyses of rare earth elements responsive genes in the eukaryotic model Saccharomyces cerevisiae. *Nicolas Grosjean*
- **11:00-11:20** Molecular and cellular approaches to unravel the effects of rare earth elements in the model bacteria *Escherichia coli*. *Didier Techer*
- **11:20-11:40** Tissue partitioning and enzymatic responses in white sea bream after exposure and elimination periods to Lanthanum. *Joana Raimundo*
- 11:40-12:10 Poster Session.

*** Lunch-Break ***







Session 2: Ecotoxicological effects of TCE. Chair: Villem Aruoja

- **13:10-13:30** Toxicity of lanthanides to freshwater microcrustaceans: bottlenecks in extrapolation of laboratory test results. *Irina Blinova*
- **13:30-13:50** Multi-toxicity of lanthanides to aquatic biota. *Elise Joonas*
- 13:50-14:10 Discussion of Session 2: Gaps, future research needs. Chairs: Laure Giamberini, Sonja Zimmermann and Villem Arouja
- *** Coffee-Break ***
- Session 3: Risk assessment + Human health. Chair: Arno Gutleb

14:40-15:10 KEY-NOTE: What is Toxicological Risk Assessment? Alberto Mantovani

- **15:10-15:30** WEEE informal recycling: global aspects and risk assessment? *Alessandra Cesaro*
- **15:30-15:50** TCEs in Public Health: hazard identification in sub-Saharan Africa *Orish Ebere Orisakwe*
- **15:50-16:10** Overview of the application and health effects on humans of the PGE (Platinum Group Elements). *Zoran Pandilov*
- 16:10-16:30 Discussion of Session 3: Gaps, future research needs. Chair: Arno Gutleb
- 16:30-17:00 Poster / Presentation Awards and Closing Discussion. Chairs: Antonio Cobelo-García and Sonja Zimmermann







KEY NOTE PRESENTATIONS

Key Speakers

Antonio Cobelo-García

Doctor in Chemical Sciences by the University of Vigo, Spain and Tenured Scientist at the Marine Research Institute in Vigo. Currently, he is the chair of the COST Action TD1407, 'Network on Technology-Critical Elements – from Environmental Processes to Human Health Threat's (2015 - 2019) funded by European Framework Programme Horizon 2020.

Arno Gutleb

Group Leader at the 'Life Cycle Sustainability and Risk Assessment' research unit of the Luxembourg Institute of Science and Technology (LIST). His research involves among others: toxicity of nano-materials, endocrine disrupting compounds and human biomonitoring.

Alberto Mantovani

Senior scientist at the Department of Food Safety, Nutrition and Veterinary Public Health at the Istituto Superiore di Sanità in Italy. Since 1987 he has been responsible for the reproductive and developmental toxicology unit at the ISS. His research is focussed on Risk assessment of endocrine-active compounds.

Experimental Setup of TCE Exposure Experiments:

Critical Considerations for Kinetically-Hindered Elements

Antonio Cobelo-García, Ana Romero-Freire

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In order to assess and prevent the impact that the increase of the anthropogenic use of the socalled Technology-Critical Elements (TCE) may have on the biosphere, the availability of ecotoxicological data of these elements becomes essential. Among the TCE, the platinum-group elements Pt, Pd, and Rh, are of especial relevance since they have been used as active components in autocatalysts for three decades now, leading to a significant contamination in those areas exposed to vehicular traffic. There exist now in the literature different exposure studies investigating biological availability, uptake and bioaccumulation of these platinum-group elements as well as their effects on different toxicological endpoints.

Given that bioaccumulation of a certain element greatly depends on its speciation, bioaccumulation studies should be carried out at conditions that ensure that equilibrium conditions are attained at the experimental conditions used (e.g. pH, salinity). This, however, can become tricky for elements with more than one oxidation state in natural waters and/or are known to display extremely slow kinetics, which is the case of Pt. In this study we will show the results of the changing speciation – monitored using UV-VIS spectroscopy – of both Pt(II) and Pt(IV) when spiked as their chloride forms (PtCl₄²⁻, PtCl₆²⁻) to (i) Milli-Q water, (ii) 0.6M NaCl, (iii) natural river water, and (iv) natural seawater, using starting Pt concentrations in the order of those typically employed for exposure studies. Results will be discussed in terms of how equilibration time of the spiked Pt on the exposure media before the bioaccumulation/ecotoxicological experiment is started may impact the results obtained.

NEW TRENDS IN INVERTEBRATE ECOTOXICOLOGICAL TESTING APPLIED TO NANOMATERIALS

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Abstract

The potential toxicity of nanomaterials (NMs) is of high societal and scientific interest, due to the promise of groundbreaking innovations for many technical applications. However, there are many pitfalls for the novice in NM toxicity testing. Not all techniques and standard procedures that have been developed and validated over decades to test chemicals can be applied in exactly the same way to NMs. Applying standard tests to the assessment of hazard of NMs without considering the possibility of artifacts due to their particulate form and particle specific behavior could lead to misevaluation of the toxicity potential due to falsepositive and/or false-negative results.

Algae, crustaceans, worms and bivalves have been used as non-vertebrate model species in recent years to study NM toxicity. Invertebrate species, for which standardized protocols exist (e.g. OECD TG 201 and 210) such as daphnids and worms, are widely used for toxicological assessment of chemical substances and NMs in aquatic systems. In addition, other organisms such as *Gammarus* sp. attained increasing attention in recent years.

The fact that there is a discrepancy in relevance of results from organisms exposed to NMs in artificially pristine laboratory conditions compared to field conditions needs specific attention. Numerous studies have shown that the NM composition and the composition of the biological molecules present (e.g. human serum, cell culture media containing dispersants such as SDS or albumin etc.) influences the identity of the biomolecules in the so-called nanoparticle corona when tested. Recently the first reports of an environmentally relevant protein corona confirmed that the concept of the protein corona is equally applicable to ecotoxicological investigations in soil and aquatic species as to toxicological ones. The understanding of these processes will also contribute to refinement and more realistic toxicity testing.

Toxicity data need careful description of the exposure scenario, uptake, localization in cells or tissues in combination with a battery of relevant endpoints ranging from molecular events all the way to highly relevant behavioural endpoints.

There is a need to have standardized acceptable methods for the toxicological assessment of NPs for regulatory purposes such as REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals).

What is Toxicological Risk Assessment?

Alberto Mantovani

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Abstract

Toxicological risk assessment is the structured and standardized approach used by scientists to address questions by risk managers about the safety of use and/or the tolerable levels in the environment and food of chemicals. The conceptual framework of risk assessment is rooted into a few common sense questions: 1) what are the effects? (hazard identification); 2) how and at what dose level the effects occur (hazard characterization); 3) how much substance one is likely to get (exposure assessment); 4) what is the chance of adverse effects at a given exposure level, including the most vulnerable (exposed or biologically susceptible) subjects (risk characterization).

This simple and step-wise structure still holds after decades of use; in the meanwhile, decades of use have outlined the complexities that are inherent to each step:

- Hazard identification must take into account of aspects which are of high public health relevance but that the current toxicological tools do cover incompletely (e.g., endocrine disruption, developmental neurotoxicity) or insufficiently (e.g. childhood tumours, metabolic syndrome)
- The definition of a toxicological "threshold", i.e. a dose level that do not cause adverse effects, is increasingly burdened by uncertainties. As a response, the use of the Benchmark Dose and of the Margin of Exposure approaches is increasingly taking place
- Exposure assessment has several problematic issues, such the identification and weighing of different intake sources (e.g.: the aggregation of dietary and non-dietary sources; in food, an added trace element plus background) and the socio-cultural aspects that modulate exposure
- Acritical aspects in risk characterization is the definition of the population groups with enhanced exposure and/or susceptibility; in particular, children are considered both as more exposed (e,g., higher food and water intake per kg body weight) and more biologically susceptible to a number of adverse effects (e.g., neurotoxicity, immunotoxicity).

Overall, an aspect of high and increasing relevance is the characterization and assessment of the impact of uncertainties on risk assessment.

Finally, some mention is made of the up-to-date issue of benefit-to-risk assessment which is triggered by scenarios (e.g., food commodities like fish, the addition to food of essential, but potentially toxic, elements like selenium or iodine) where nutritional benefits and toxicological risks may be concurrently envisaged.

ORAL PRESENTATIONS

Electrochemical methods of Pd determination at trace level

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Abstract

Constant increase of the content of platinum group elements in the environment creates the need for their monitoring. As there are no adequate reference materials with certified (or even estimated) palladium content, it is necessary to develop analytical methods and procedures for palladium determination at very low concentration levels. From the perspective of environmental analysis it is important to develop a variety of analytical methods, which are based on different physicochemical phenomena, and allow to obtain correct results for a broad range of sample matrices. The most often applied are spectral methods – graphite furnace atomic absorption spectrometry (GF AAS) and inductively coupled plasma mass spectrometry (ICP MS), but these methods are sensitive to many interferents, such as Cd and Zn, which content in natural samples is often much higher than Pd. Stripping voltammetry seems to be a good alternative to these methods, because signals registered after inversion of the polarization are significantly amplified. Unfortunately, so far the limits of quantification of voltammetric methods are much higher for Pd than in case of two other PGEs – platinum and rhodium. Moreover, many voltammetric methods of Pd determination relay on the use of the hanging mercury drop electrode as a working electrode. As liquid mercury electrodes are toxic, their usage has become restricted increasingly often. Alternatively Hg can be used either in the safe form of an amalgam, or in very small amounts. Also application of bismuth electrodes seems to be quite promising. Independently of the applied analytical method, before Pd determination in real samples different methods of analyte separation/preconcentration are applied. In our project we aim at developing a whole analytical procedure for Pd determination, including the steps of Pd separation from sample matrix, deposition and/or preconcentration, and electrochemical determination, which will allow detection of Pd at ppt level. Various constructions of working electrodes are tested in order to combine selective deposition (Pd complexes on ion-exchanger, chelating agents) and effective preconcentration (different compositions of the active layer of working electrode). Optimized and validated methodology of palladium determination will be applied to natural samples (wide range of concentrations), and eventually allow to monitor the changes of Pd concentration in the environment.

This study was supported by National Science Centre, Poland, project no. 2016/23/D/ST4/00836.

Additional characterization of the Danube sediments is Serbia including some technology-critical elements

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Abstract

Application of Technology-critical elements (TCEs) rapidly increases in last decade, and their presence in the environment start to be detectable. The aquatic sediments absorb the organic and inorganic pollutants in higher level comparing with their concentration in water. Although, the Danube River has been well examined in a sense of heavy metal pollution, investigation of the presence of TCEs has not been investigated yet. The environmental impact of the dam includes alteration of the hydrological regime on the surface and ground waters, and change of the sediment regime [1]. The most important consequence of the constructing Iron gate I (a dam at 947 km of river Danube) is constant increasing of amount of sediments. There are several indications that the largest impoundments of the River Danube (Iron gate) represents some kind of sink for pollutants [2]. The aim of this study is determination some of TCE (Ta, Ga, La, Ce, Nd, Sm, Eu, Gd, Tb, Dy, Yb) in the Danube River sediment by Neutron Activation Analysis.

The samples were collected from 1141 km to 846 km of the Danube River and three tributaries on this way. The analytical procedure for determination of the selected elements based on NAA has been described in detail elsewhere [3]. The TCEs concentration un the analysed sediments connected with hydropower dam and reservoir systems Iron gate I and Iron gate II (863 km) were compared with samples before and after these places.

Determined concentration of the TCE into the Danube sediment samples were also compared to elemental composition of rock standards. It was found that Nd, Eu and Dy have slightly increased concentration in Danube sediments. This is probably influence of anthropogenic changes.

References:

[1] Babić Mladenović M., Kolarov V., Damjanović V., (2014): Sediment regime of the Danube River in Serbia, International Journal of Sediment Research 28, 470-485.

[2] Reschke S., Htekkot V., Panin N., (2002): The Nature of Organic Matter in the Danube River Particles and North-western Black Sea, Estaurine, Costal and Shelf Sciences 54, 563-574.

[3] Frontasyeva, M.V., (2011). Neutron activation analysis for the life sciences. A review. Phys. Particles Nuclei 2, 332–378.

Milk and dairy products authentication based on their isotopic and elemental profile

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Abstract

Stable isotope ratios of bio-elements (2H/1H; 18O/16O; 13C/12C; 15N/14N), combined with elemental profiles has often been used for the determination of the authenticity of different food products (i.e. wines, fruit juices, vegetables, milk and dairy products) with respect either to their production area or to species. A special attention is given nowadays to a very strict control of food traceability because; some consumers associate the geographical origin of a certain product with its quality. Besides milk authentication with respect to geographical origin, another important issue relates to the detection of milk produced by different animal species; many people are allergic to cows' milk and therefore they consume milk from other animals, e.g., sheep or goats. Previous studies have shown that the corroboration, through chemometric techniques, of isotopic and elemental profile could be a useful tool for distinguishing both geographical origin and animal species.

This study presents the best marker association for the discriminations of both geographical origin and also, for species differentiation for different types of milk and cheeses produced in three Transylvanian farms. A special accent is given in this work to the discrimination potential of some TCEs and also to the relationships among them.

References:

[1] Magdas, D.A., Dehelean, A., Feher, I., Cristea, G., Puscas R., Dan S.D., Cordea D.V., (2016): Discrimination markers for the geographical and species origin of raw milk within Romania, International Dairy Journal 61 (2016) 135-141

Rare earth elements (REE) transport from soil to olive and olive oil

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Olive products are part of the traditional Mediterranean diet whose popularity among consumers all over the world has been increasing in the last decades because of its healthy properties. In Croatia, olive trees are of a special concern as they are widely cultivated species along the Croatian coast. Trace elements analyses play an important role for oil characterization, regarding its quality control and definition of geographic origin. If the transport of elements from soil to oil is subjected to minor variations multielemental composition of oils may be used for geographical traceability. It is known that the pattern of REE in soil is directly related to the local and regional geology. However, soil characteristics, environmental conditions and agricultural management are likely to drive variations in plant REE uptake and consequently their transport to olive, leaves, fruits and oil.

In this work, we studied the influence of soil properties and environmental conditions on the uptake of REE by olive trees. Samples of soils were taken from different pedological settings (terra rossa, rendzic leptasol and anthropogenically modified lithosol) in olive orchards from the main Croatian olive-growing regions (Istria, Kvarner, northern, central and southern Dalmatia). Composite samples of olive leaves were also collected and wet olive pomaces and virgin olive oils were produced after harvest in the laboratory extraction system. Samples of soil, olive leaves, pomace and olive oils were analysed for their REE content by HR ICPMS after adequate MW digestion of solid samples and acid extraction in the case of olive oil. Characteristics of soils (pH and carbonate content), as well as the REE fraction available to plant (estimated by extraction with ammonium nitrate), were also determined. Obtained data indicated that the REE composition of olive leaves is dependent on the pedo-geochemical characteristics of related soils and that bioavailable fraction of REE is successfully transported into olive pomace and oil. REE distribution in olive leaves, pomace and oil were further discussed in relation to the soil characteristics and geographic origin. Normalized REE patterns, Multivariate Redundancy Analysis and correlation analysis were used to elucidate the relationship between analysed parameters.

The presented data are part of the larger data set (multielemental composition) which should enable development of a geochemical method for geographical traceability of Croatian virgin olive oils.

Time-Series (1991-2014) Trends of Technology-Critical Elements Accumulation in Mussels from an Urban Coastal Area (Vigo Ria, NW Iberian Peninsula)

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Abstract

Current technologies such as electronics, medicine or computer science are evolving rapidly and they need a set of key components for its development, elements that are at very low concentration (<100ppm) but are key for the manufacturing of e.g. batteries, magnets, medical equipment, alloys or everyday products such as lamps, TV, signals or lasers.

The importance of the study of these key elements known as Technology-Critical Elements, TCEs, has increased because of its growing use and release into the environment which can cause changes in their biogeochemical cycles. The TCEs can be bioaccumulated by organisms and their impact needs to be studied more precisely.

In order to shed further light in this area, we present in this study the time-series (1991-2014) trends in concentrations of several TCEs in mussel samples (*Mytilus galloprovincialis*) collected in an urban beach from the Vigo Ria (NW Iberian Peninsula). The TCEs analyzed were Pt, Y, Ta, Nb, Tl, Au, Ag and the rare earth elements (REEs: Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Er, Tm, Yb, Lu). The only element that showed a significant temporal trend linked to human activities was Pt (Neira et al., 2015), an element whose environmental inputs has been linked to its use in catalytic converters in cars. For the other elements, no evident trend was observed except a decreasing trend for Au and Ag. However, REEs show a strong correlation between them and a temporal increase of light-to-heavy ratios (LREEs/HREEs).

The uptake of each element depends on its chemical properties, its concentration in the environment and also the hydrological conditions (e.g. upwelling events, renewal of water) have a major influence. Accordingly, the influence of natural processes on the bioaccumulation of TCEs will be discussed.

References:

[1] Neira, P., Cobelo-García, A., Besada, V., Santos-Echeandía, J., Bellas, J., (2015): Evidence of increased anthropogenic emissions of platinum: Time-series analysis of mussels (1991-2011) of an urban beach, Science of the Total Environment, 514, 633-370.

Platinum accumulation in marine organisms – outcomes from an exposure experiment and field observations

M. Abdou^{1*}, J. Schäfer¹, L. Dutruch¹, R. Hu¹, B. Zaldibar², R. Medrano², U. Izagirre², T. Gil-Díaz¹, A. Coynel¹, G. Blanc¹, M. Soto²

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Abstract

With the ongoing changes in resource use and technological progression, many elements undergo major disturbance of their geochemical cycles. This is the case of a group of elements named Technology Critical Elements (TCEs) that includes platinum element (Pt). Regularly introduced in cars from the early 1990's, different environmental compartments have recorded this ongoing change in Pt use. Yet, knowledge on Pt levels in aquatic systems and more particularly in marine environments, including biota, is still extremely scarce. This study presents the main outcomes from an exposure experiment on marine bivalves [1]. Wild oysters (Crassostrea gigas) were exposed to isotopically-labelled Pt in seawater for 35 days. Rate and kinetics of dissolved Pt accumulation in oyster soft tissues were investigated. By showing high Pt accumulation potential, oysters proved to be suitable sentinels for Pt levels, ensuring biomonitoring of Pt concentrations in marine coastal waters. Historical records of Pt concentrations in marine bivalves (oysters C.aigas, and mussels Mytilus edulis) from two coastal urbanized environments (respectively the Gironde Estuary and the Toulon Bay; [2;3]) were therefore studied. The chronicled samples displayed Pt concentration variations that reflect the evolution of Pt pressure in these ecosystems through time. In addition to those historical records, Pt levels were also investigated in other biota samples including mussels and phytoplankton from several coastal sampling sites. These results suggest that anthropogenic vehiclederived Pt emissions may profoundly affect Pt inputs in the system inducing enhanced Pt uptake by biota. Considering the paucity of data on the distribution of Pt in aquatic environmental matrices, and especially in marine systems, monitoring programs on Pt should therefore be conducted in the future [4].

References:

[1] Abdou M., Dutruch L., Schäfer J., Zaldibar B., Medrano R., Izagirre U., Gil-Díaz T., Bossy C., Catrouillet C., Hu R., Coynel A., Lerat A., Cobelo-García A., Blanc G., Soto M. (2018). Tracing platinum accumulation kinetics in oyster *Crassostrea gigas*, a sentinel species for Pt concentrations in coastal marine environments. Science of the Total Environment, 615, 652-663.

[2] Abdou M., Schäfer J., Cobelo-García A., Neira P, Petit J.C.J., Auger D., Chiffoleau J.-F., Blanc G. (2016). Past and present platinum contamination of a major European fluvial-estuarine system: Insights from river sediments and estuarine oysters. Marine Chemistry, 185, 104-110.
[3] Hu R. (2018). Anthropogenic platinum contamination in blue mussels (*Mytilus edulis*) and sediments from a coastal system (Toulon Bay, France). Master Thesis (*unpublished data*).
[4] Zereini F, Wiseman C.L.S (2015). Platinum in the environment. Springer, 492pp.

Effect of humic substances on the behavior of palladium in water and its bioaccumulation by Zebra mussels

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Abstract

In the last decades, the growing input of palladium (Pd) derived from its use in automobile catalytic converters and other sources into aquatic ecosystems, has become an issue of emerging concern. Humic substances have been highlighted for their role in binding Pd, playing a significant role its transport and bioavailability¹. However, the knowledge on the environmental processes that regulate Pd behavior in aquatic ecosystems and its ecotoxicological relevance is still scarce.

In this exposure study with zebra mussels (*Dreissena polymorpha*), the behavior of Pd in the tank water as well as the Pd uptake kinetics were monitored during an exposure period of 7 days using an environmentally-relevant Pd concentration of 10 μ g/L. The influence of different humic substances was investigated by using different aqueous exposure media: reconstituted water without humic substances (PdRW), reconstituted water + fulvic acids (PdFA), reconstituted water + humic acids (PdHA) and natural water from a pond (PdNW). The Pd concentration in the tank water was stabilized by pre-conditioning of the tanks before start of the mussel exposure.

Electrothermal atomic absorption spectrometry (ET-AAS) analysis revealed more than 50% Pd removal in the tank water as compared with the nominal exposure concentration. The presence of humic substances had a minor impact on the Pd concentrations in the tank water. Despite of the low metal exposure concentration, Pd uptake was detected in the mussel soft tissues of all Pd exposed groups even after just one hour of exposure. Additionally, during the initial exposure period of 9 h, the presence of humic acids clearly enhanced the Pd uptake whereas the uptake kinetics of the mussels of the PdRW-, PdFA- and PdNW-group showed no significant differences. However, after 3 days of exposure, all mussel groups demonstrated comparable Pd concentrations.

Furthermore, preliminary results on the biofilm abundance in the tanks with natural pond water indicated that Pd, even at the low exposure concentrations used, may negatively affect the biofilm growth. However, this has to be confirmed in future investigations.

References:

[1] Sures, B., Zimmermann, S., 2007. Impact of humic substances on the aqueous solubility, uptake and bioaccumulation of platinum, palladium and rhodium in exposure studies with *Dreissena polymorpha*. Environmental Pollution 146, 444–451. https://doi.org/10.1016/j.envpol.2006.07.004

Toxicokinetics of Gd and Gd-Lu mixture in Daphnia magna

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Abstract

Concentrations of rare earth elements (REEs) are expected to rise in the waterbodies as a result of increasing phosphorus fertilizer use and production and waste of modern technology commodities. Thus, determination of REE bioavailability and toxicity to aquatic biota is of growing interest. REE bioaccumulation has been shown to be higher in zooplankton and benthos compared to fish [1]. The zooplanktonic species *Daphnia magna* can be especially vulnerable because it accumulates considerable amount of Ca²⁺ in the carapace and REEs have been shown to disturb the Ca²⁺ metabolism in other crustaceans [2]. In this study, the toxicokinetics of a single REE (Gd) and of a mixture of two REEs (Gd and Lu) in *D. magna* were measured to determine their uptake, elimination and effect on elemental body composition.

13–14 day old *D. magna* were exposed to 6.8 mg/L Gd or a mixture of 3.4 mg/L Gd and 3.4 mg/L Lu for 48 h followed by a 24 h elimination period in uncontaminated OECD202 artificial freshwater [3]. Daphnids and test media were sampled at t = 3, 6, 12, 24, 36 and 48 h (uptake phase) and at t = 54, 60 and 72 (elimination phase).

ICP-MS measurements of filtered (0.22 μ m) and unfiltered aliquots showed that, although total REE content was the same (6800 μ g L-1) for the two treatments, the filterable REE fraction was higher in the treatment with a mixture 1:1 of Gd:Lu. Visual Minteq modelling results predicted considerable precipitation (over 95%) of REEs in both treatments.

Toxicokinetic modelling indicated higher uptake and elimination of Gd compared with Lu. Daphnids' REE concentration was negatively correlated to Ca, Mg and Na body contents, but there was no significant difference in Ca concentration between control and exposed daphnids. X-ray fluorescence spectrometry imaging showed that 24 h after the start of the exposure, most of the REEs had accumulated in the hepatic diverticulum of the gut in Gd treatment and inside the gut in Gd-Lu treatment.

References:

[1] Amyot, M., Clayden, M.G., MacMillan, G.A., Perron, T., Arscott-Gauvin, A., (2017). Fate and Trophic Transfer of Rare Earth Elements in Temperate Lake Food Webs, *Environmental Science & Technology*, 51, 6009–6017.

[2] Bosco-Santos, A., Luiz-Silva, W., da Silva-Filho, E.V., de Souza, M.D.C., Dantas, E.L., Navarro, M.S., (2017). Fractionation of rare earth and other trace elements in crabs, *Ucides cordatus*, from a subtropical mangrove affected by fertilizer industry. *Journal of Environmental Sciences*, 54, 69–76.

[3] OECD, (2004). OECD Guidelines for the Testing of Chemicals. *Daphnia* Sp. Acute Immobilisation Test (Guideline No. 202). OECD, Paris, France.

Increasing levels of Technology-Critical Elements (TCE) by mining activities: exposure to living organisms in estuarine sediments

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Abstract

Mining is an important source of pollutants into the environment. As a result of mining activities, soil is generally degraded and increasing metal particulate fluxes into the hydrosphere are commonly observed. Mining can also lead to growing levels of dissolved metal concentrations. This is the case of sulfide mining, where the occurrence of acid mine drainage (AMD) processes enhances the solubility of metals at low pH values [1]. While the mobility and exposure pathways of base metals in AMD environments have been widely studied [2], less attention have received the Technology-Critical Elements (TCE; e.g. rare earth elements (REE), Ta, Tl, In, Te, Nb, Ga or Ge). This study aims at assessing the impact of mining activities on the accumulation of some TCE in estuarine sediments historically affected by AMD in the Ría de Huelva Estuary (SW Spain). Eight sediment cores (140 cm depth) were collected at different locations. The cores were sliced at different depths, the age of each layer was dated and the content of TCE was obtained after digestion and analysis by ICP-MS. Results evidence the enrichment of TCE in estuarine sediments coinciding with intense periods of mining activity. Geochemical and toxicity tests suggest a lower mobility and risk to living organisms for TCE than for base metals.

References:

[1] Cánovas, C.R., Olías, M., Nieto, J.M., Sarmiento, A.M., Cerón, J.C., (2007): Hydrogeochemical characteristics of the Odiel and Tinto rivers (SW Spain). Factors controlling metal contents. Sci. Total Environ. 373, 363–382.

[2] Nordstrom, D.K., (2011). Hydrogeochemical processes governing the origin, transport and fate of major and trace elements from mine wastes and mineralized rock to surface waters. Appl. Geochem. 26, 1777–1791.

Are lanthanide mining exploitations a source of environmental toxicity?

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Abstract

Lanthanides (LNs) have a low tendency to appear concentrated in exploitable ore deposits, however in last years they have become a highly valuable commodity. Therefore the exploitation of areas with rocks bearing LNs is a main progressing activity and opening of mining facilities is being actively explored. In these new exploitations LN released into the environment could happen and it has been evidenced before that LN can be detrimental. Thus, this project focuses on if and how opening of LN mines will alter the normal ecology of aquatic biota.

In this study leaching of rocks, according the ISO/TS 21268-2 [1], was performed with four rock materials sampled in prospective REE mining areas in Quebec (Canada): ferro- (FER) and calico- (CAL) carbonatite; monazite- (MON) and allanite- (ALA) bearing pegmatite. The leaching was performed during one month with rainwater similar to the one in the site and following dry/wet cycles for simulating real conditions. In 6 periods of leaching (1, 3, 7, 14, 21 and 28d) metal analyses in the eluents were done (ICP-MS, ICP-OES). In addition, at 1 and 28d, four toxicity tests with representative organisms were done: decomposer (*A. fischeri*) > primary producer (*R. subcapitata*) > primary consumer (*D. magna*) > secondary consumer (*D. rerio*).

Although rocks in the studied area have LN contents up to 12,000 ppm, the LN availability in the eluents was <0.1 ‰ at 1d, and decreased drastically in the next day (3d) with reductions between 75-94% and without further significant variations with ageing. At 1d, LN contents were in all eluents higher than LN found in river waters in Quebec, and observed enrichments remained in all studied periods for ALA and MON, additionally, in some cases values were higher than the maximum permissible LN concentrations [2]. The eluents showed contrasting toxic results for the different aquatic organisms tested (e.g., *D. magna* had 100% of inhibition in MON but for *A. fischeri* this rock did not show toxicity), and besides toxicity not necessarily decreased at 28d.

Our findings suggest that LNs could be leaching towards the aquatic interfaces in mining areas in μg to mg ranges, and, in addition, as they bore toxic effects in the lixiviation at 1 and 28d, more studies should be carried out to assess LN toxicity and to define ecological safety levels in these future mining areas.

References:

[1] ISO (2007): Leaching procedures for subsequent chemical and ecotoxicological testing, ISO/TS 21268-2, pp.18.

[2] Sneller, F.E.C., Kalf, D.F., Welje, L., van Wezel, P., (2000): Maximum Permissible Concentrations and Negligible Concentrations for Rare Earth Elements, (601501), 66.

Environmental Risks of Nanomaterials, their Toxicity and Methods of Determination

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Abstract

Nanotechnology has gained a great deal of public interest due to the needs and applications of nanomaterials in many areas of human operations including industry, agriculture, business, medicine and public health. Engineered nanomaterials are rapidly becoming a part of our daily life in the form of cosmetics, food packaging, drug delivery systems, therapeutics, biosensors, and others. The rapid growth in the commercial application of engineered nanomaterials will certainly increase the exposure to these metals among humans and in the environment. Nanoparticles (NPs) of silver and gold, as well as silicon, zinc, copper and titanium oxides are most often used, so far. The information regarding nanoparticles of Platinum Group Elements and Rare Earth Elements is relatively premature and scarce, which has led to the current controversy regarding the health benefits vs toxic effects of these materials on living organisms and their release into and presence in the environment. In the presentation a summary of recent research efforts on fate, behavior and toxicity of different classes of nanomaterials in the environment will be presented.

Size of metal-based nanoparticles is an important factor determining their physical and chemical properties as well as their bioavailability and toxicity. To assess the environmental and toxic impact of nanomaterials a reliable methods for the size characterisation of NPs in different matrices (consumer products, biological and environmental samples) are required. In addition to size analysis, it is important to carry out speciation analysis of various forms of metal, namely metal-containing nanoparticles and corresponding metal ions. Therefore, the methods used for comprehensive characteristics of nanoparticles will be also reviewed.

Multibiomarker assessment of cross effects of salinity and cerium nanomaterials on the freshwater bivalve *Corbicula fluminea*

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Abstract

Cerium nanomaterials (CeNMs) are integrated in consumer products (e.g. wood stain, painting, fuel additive) because of their strong abrasive power, high resistance and UV-shielding properties. Given the production volumes of CeNMs and their potential release into the aquatic environment, assessment of the potential environmental risks of CeNMs is a priority. While the impacts of nanomaterials in freshwater have been studied this last decade, studies including the influence of environmental factors as salinity are scarce. Safety of nCeO₂ should be considered because harmful effects have already been demonstrated. Studies are nevertheless controversial reporting either toxic effect, no apparent effect or even beneficial one. Most studied parameters were about behavioural changes, enzymatic reactions or cellular damages whereas gene expression level is poorly considered. Nevertheless molecular change is the first organism response to environmental modifications. In this context, the aim of the present study is to assess the fate, behaviour and toxicity effects of CeNMs under different salinities using the euryhaline bivalve, Corbicula fluminea and a multi-marker approach at different levels (molecular and sub-cellular) of biological organization. The CeNMs included in a commercial fuel additive (Envirox[™]) at two stages of its life cycle and NM-212, a standardized CeNMs provided from the Joint Research Centre, suspended in water covering salinity from continent (1.5 psu) to esturaries (15 psu). The exposure was conducted under indoor pocked-size mesocosms during 28 days by injecting punctually 91 µg/L CeNMs to reach a final concentration of 1 mg/L. The size, shape and mineralogy of the uncombusted and combusted Envirox[™] were performed by Transmission Electron Microscopy. Total Ce in the water column, labile forms of Ce and Ce contents in the bivalves were estimated by ICP-MS. Organisms were collected after 7, 14, 21 and 28 days. Biochemical responses (oxidative stress, cell damage, energetic reserves) were measured in the digestive gland using the spectrophotomer automate Konelab 20Xti. Gills were taken and stored until mRNA extraction for gene expression analysis by RT-qPCR. This analysis was done on 12 genes of interest involved in antioxidant and antitoxic reactions, general response to stress, autophagy or cell structure. All the biomarker data were analysed using a statistical model, LDA or PLS-DA analysis. The behaviour of the CeNMs in the water column was different according to the salinity and their coating. Results showed that digestive cellular damage and antioxidant defences were activated during a long term exposure. Global profiles of gene expression in gills appeared strongly different according to the salinity. Both Envirox[™] exposures often induced responses different from the control but not significantly different between them. The originality of this study was not only the use of CeNMs directly extracted from commercial product or artificially aged, but also the multistress exposure combining salinity. Moreover, studying gene expression changes is an earlier way to detect NMs impact.

Genome-wide analyses of rare earth elements responsive genes in the eukaryotic model *Saccharomyces cerevisiae*

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Abstract

The Rare Earth Elements (REEs) group gather 17 chemical elements including 15 lanthanides, Yttrium and Scandium. As part of the Technical Critical Elements (TCEs), they are of high importance in high-tech domains from sustainable energies to medicine. Although many investigations have been carried out to find innovative ways to supply the rising demand for these elements, the effects of the increasing release of these new emerging contaminants in the environment is poorly documented. Furthermore, the few existing studies on biota often mention controversial effects and therefore reflect the lack of knowledge on the impact of REEs at the cellular level. Thus, we adopted high throughput strategies to study REE stress responses in the eukaryotic model Saccharomyces cerevisiae. The screening of a genome-wide mutant collection and a transcriptomic analysis (RNA-seq) were performed in the presence of toxic concentrations of several REEs. These two complementary large-scale methods allowed the identification of key genes, proteins, pathways and compartments involved in a REE stress as well as their translocation in Saccharomyces cerevisiae. The stress response triggered by these REE elements obtained on this model organism highlights the potential impact of REEs on eukaryotic organisms at the cellular and molecular levels.

Molecular and cellular approaches to unravel the effects of rare earth elements in the model bacteria *Escherichia coli*

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Abstract

The broad usage expansion of rare earth elements (REE) in technologies, agriculture and medicine makes these elements to be now considered as emerging contaminants. The fast growing global demand for these technology critical elements requires a thorough evaluation of their potential ecotoxicological hazard, as well as a better understanding of the role of microorganisms on their environmental fate. So far, interactions of REE with prokaryotes have been reported in a few studies, showing REE adsorption at the bacterial cell surface, thus locally increasing the REE concentration [1], REE intracellular accumulation [2] and antibacterial effects [3]. However, the molecular basis and cellular mechanisms involved in these processes remain undefined. Although some beneficial effects of REE have been documented for eukaryotic organisms (*e.g.* plant growth stimulation), a systematical study aiming at determining the previously hypothesized hormetic effects in bacteria is still lacking. Likewise, several studies refer to oxidative stress induced after REE exposure, without precisely characterizing the possible specific effect of the different REEs. In the present study, we proposed to study the impact of light and heavy REE on bacterial growth in the prokaryotic model Escherichia coli. In order to assess and better characterize the possible REE-mediated beneficial and/or toxic effects, cellular parameters related to oxidative stress and membrane permeability were also evaluated based on flow cytometry assays. Moreover, complementary high-throughput approaches relying on both genomic phenotyping of mutants and transcriptomic analyses gave insights into the molecular mechanisms involved in the REE-mediated stress response in E. coli.

References:

[1] Takahashi, Y., Yamamoto, M., Yamamoto, Y., Tanaka, K., (2010): EXAFS study on the cause of enrichment of heavy REEs on bacterial cell surfaces, Geochimica et Cosmochimica Acta 74: 5443–5462.

[2] Bayer, M.E., Bayer, M.H., (1991): Lanthanide accumulation in the periplasmic space of *Escherichia coli* B., Journal of Bacteriology, 173: 141-149.

[3] Weltje, L., Verhoof, L.R., Verweij, W., Hamers, T., (2003): Lutetium speciation and toxicity in a microbial bioassay: testing the free-ion model for lanthanides, Environmental Science & Technology, 38: 6597-6604.

Tissue partitioning and enzymatic responses in white sea bream after exposure and elimination periods to Lanthanum

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Abstract

Rare earth elements (REE) play an essential role in the development of innovative environmental technologies, and with this increasing application emission to freshwater and marine systems is expected to increase. Lanthanum (La) is the first element of the lanthanides (or lanthanoides), a series of 15 metals from La to Lu [1]. Although dissolved La species represent a very small proportion in water and sediment, the trivalent ion La³⁺ is bioavailable and possesses the greatest risk of biological effects [2]. As with other lanthanides (III) ions, La have many biological properties, which are based especially on similarity with Ca ions. This study aims to evaluate the uptake, distribution and accumulation of La in gills, blood, liver, kidney and brain of white sea bream (Diplodus sargus) over 14 days of exposure followed by 14 days of elimination. Fish were exposed to realistic waterborne La concentrations to produce reliable data for an assessment of the environmental status (60 ng L^{-1}). Prior to La exposure, fish were acclimatized to the experimental conditions and routines for two weeks. Ten fish were sacrificed at each sampling period: at the beginning of the experiment (T0), after 1 (T1), 3 (T3), 7 (T7) and 14 (T14) days of exposure and after 14 (T28) days in clean water. Control fish were kept throughout the experiment in tanks filled with clean seawater. Immediately after collection, the fish were weighed, measured, and sacrificed by cervical transection. Blood was collected, and the gills, liver, kidney and brain removed. The gills were carefully washed in distilled water and the filaments separated. All the biological samples were stored at -20 °C until La determinations (ICP-MS), except for a part of the liver that was stored at -80 °C for enzymatic analyses (CAT, Lipid peroxidation, AChE). Concentrations of La showed a significantly increase after 1 day of exposure, followed by a sharp decreased at T3 diminishing to levels similar to the control until the end of the experiment. Enzymatic responses in the liver were irregular with increments and reductions along the sampling periods. The observed results could be linked to the La property to block calcium channels or to the replacement of calcium(II) ions is structure of many proteins, which means that these proteins can lose their functions, or, contrariwise, in some cases their function can be activated or increased [3; 4].

References:

[1] Holden, E., Coplen, T. (2004). The periodic table of the elements. Chem. Int. 26 (1), 8–9.

[2] Das, T., Sharma, A., Talukder, G. (1988).Effects of lanthanum in cellular systems. Biol. Trace Elem. Res. 18(1), 201–228.

[3] Mácová, S., Babula, P., Plhalová, L., Žáčková, K., Kizek, R., Svobodová, Z. (2010). Acute toxicity of lanthanum to fish *Danio rerio* and *Poecilia reticulate*. J. Biochem. Tech. 2(5), S46-S47.

[4] Herrmann, H., Nolde, J., Berger, S., Heise, S. (2016). Aquatic ecotoxicity of lanthanum – A review and an attempt to derive water and sediment quality criteria. Ecotoxicol Environ Safet 124, 213–238.

Toxicity of lanthanides to freshwater microcrustaceans: bottlenecks in extrapolation of laboratory test results

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Abstract

The application of lanthanides in different sectors of the world economy has significantly increased during last two decades. This process is accompanied by emissions into the environment via different pathways. The "anthropogenic" anomalies of lanthanides in soil, surface water, groundwater and even in tap water have already been registered. The disruption of the natural biogeochemical cycle of lanthanides increases the risk of biota being exposed to elevated concentrations of lanthanides. However, the ecotoxicological effects of these elements and their fate in the environment are still insufficiently understood. The reported toxic concentrations, e.g., for Daphnia magna, noticeably vary presumably due to different test conditions. Differences in the chemical composition of the test media lead to highly variable bioavailability of lanthanides since lanthanides form complexes with various inorganic and organic ligands. Other factors such as temperature, expose time, etc. also affect the test results. Thus, bioavailable fractions of lanthanides added at equal nominal concentrations may noticeably vary depending on the test design. Although laboratory toxicity tests performed under controlled conditions provide information on toxicity of lanthanides, the applicability of obtained toxicity data for meaningful risk assessment remains questionable as wrong interpretation of the test results may lead to over/underestimation of real risks.

In the current presentation, the environmental relevance and problems in the interpretation of the data on toxicity of lanthanides obtained using different formats of laboratory ecotoxicity tests will be discussed. Toxicity of $La(NO_3)_3.6H_2O$, $Ce(NO_3)_3.6H_2O$, $Pr(NO_3)_3.6H_2O$, $Nd(NO_3)_3.6H_2O$ and $Gd(NO_3)_3.6H_2O$ to freshwater crustaceans *Daphnia magna*, *Thamnocephalus platyurus* and *Heterocypris incongruens* was evaluated in different test media (synthetic freshwater and natural lake water). We showed that in spite of the chemical similarity, the behavior and ecotoxicological profile of the tested elements slightly differed depending on the test conditions. More knowledge on the limitations of current techniques and on the behavior of the lanthanides in the real ecosystem is needed for elaboration of the environmentally relevant test formats. In particular, we can assert that results of acute toxicity testing of lanthanides have doubtful scientific value and cannot be used for realistic risk assessment.

Multi-toxicity of lanthanides to aquatic biota

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Abstract

The release of lanthanides (LNs) into the environment is expected to greatly increase in coming years due to a high demand for new green and high technology applications. However, there is a gap in environmental regulations regarding LNs due to insufficient ecotoxicological data. Furthermore, most of the available data concerns LN toxicity studies focusing on single element effects, when LNs are commonly found as a group in minerals and in nature. LNs are expected to have a cumulative toxic effect on organisms, owing to their similar physicochemical properties. In this work, we evaluated the effects of mixtures of cerium (Ce), gadolinium (Gd), and lutetium (Lu), representative of heavy, middle and light rare earth elements, respectively, on aquatic species belonging to different trophic levels. Bioavailable lanthanide concentrations significantly decreased during all toxicity tests, but the extent of the decrease varied across test media. We observed that the major decrease in bioavailable LN concentration takes place at the start of the tests. From a battery of seven test species including bacteria, algae, zooplankton and fish, toxic effects related to LNs were observed only in five. Unicellular organisms and rotifers were the most sensitive to LNs. The multi-toxicity approaches used in this study, concentration addition and toxic unit calculation, showed that LN mixtures had a more than additive effect to the bacterium A. fischeri and the algae R. subcapitata, thus showing more toxicity than predicted from single element effects. Less than additive toxicity was instead observed for the rotifer B. calyciflorus, meaning LNs were less toxic to it as mixtures than would be expected based on single element experiments. The differences in toxic effects obtained from the multi-toxicity approaches in this study clearly indicate that the effects of LN mixtures vary depending on the test organism. Further studies are required to properly understand their toxic behavior and the possible associated risk in real environmental settings.

WEEE informal recycling: global aspects and risk assessment

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Abstract

Waste Electrical and Electronic Equipment (WEEE) represents the fastest growing waste stream globally, characterized by high heterogeneity both in terms of materials and components [1]. The presence of rare earth elements (REEs) and platinum group metals, which have been defined as critical raw materials of industrial interest [2], is driving the identification of innovative technologies for WEEE recycling. However, as the approach to WEEE management is very diverse worldwide, in developing countries it mainly focuses on the recovery of metals like gold and copper, which is pursued without the formal identification of criteria ensuring the protection of both human and environmental health [3]. Manual dismantling, uncontrolled leaching and open burning are the most frequently reported practices that are used to liberate WEEE valuable components for further recycling under uncontrolled conditions. The issue of the hazards posed by WEEE informal treatment on human health has been extensively reported in scientific literature [4,5], but large rooms of improvements can be identified when the same issue is considered in the framework of health risk assessment.

In the context of ReCreew (European network for innovative recovery strategies of rare earth and other Critical metals from electrical and electronic waste) the characterization of WEEE informal practices as well as the development of the relative risk assessment from diverse treatment procedures have been approached. Main outcomes of this work will be presented, in order to point out the aspects that still need to be addressed to ensure the sustainable management of WEEE on a global scale.

References:

[1] Cui, J., Zhang, L., (2008). Metallurgical recovery of metals from electronic waste: a review, Journal of Hazardous Materials 158, 228-256.

[2] Cossu, R., Williams, I.D., (2015). Urban mining: concepts, terminology, challenges, Waste Management 45, 1-3.

[3] Tsydenova, O., Bengtsson, M., (2011). Chemical hazards associated with treatment of waste electrical and electronic equipment, Waste Management 31, 45-58.

[5] Sepúlveda, A., Schluep, M., Renaud, F.G., Streicher, M., Kuehr, R., Hagelüken, C., Gerecke, A.C., (2010). A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipment during recycling: examples from China and India, Environmental Impact Assessment Reviews 30, 28 - 41.

TCEs in Public Health: hazard identification in sub-Saharan Africa

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Africa is a data poor country. This is more true when dealing with chemical elements that have been considered as minor so far by the international scientific community. On the other side, the identification of "minor" (but widespread) hazards and relevant exposure pathways may highlight possible non negligible implication for certain communities in Africa, as well as unexpected cocktail effects with major metals poisoning.

Africa is a main reserve, resource and mining area for TCEs. Besides occupational exposure, certain communities in sub-Saharan Africa may be exposed to TCEs due to i) proximity of villages to mining and e-waste recycling sites and roads beaten by catalytic cars powered with petrol, ii) geophagy and consumption of foods contaminated during production or storage, iii) traditional therapeutic tattoos commonly used by traditional healers, iv) products for body image and symbols of physical beauty. Inhalation, ingestion and contact exposure pathways that are peculiar to sub-Saharan African communities are analyzed.

Overview of the application and health effects on humans of the PGE (Platinum Group Elements)

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Abstract

The platinum-group elements (PGE) include platinum, palladium, rhodium, ruthenium, iridium, and osmium. These metals have similar physical and chemical properties and occur together in nature. The properties of PGE, such as high melting points, corrosion resistance, and catalytic qualities, make them indispensable to many industrial applications. PGE are strategic and critical materials for many nations because they are essential for important industrial applications but are mined in a limited number of places and have no adequate substitutes [1].

Environmental concentrations of the platinum group elements (PGE) have been on the rise, due largely to the use of automobile catalytic converters which employ these metals as exhaust catalysts. It has generally been assumed that the health risks associated with environmental exposures to PGE are minimal. More recent studies on PGE toxicity, environmental bioavailability and concentrations in biologically relevant media indicate however that environmental exposures to these metals may indeed pose a health risk, especially at a chronic, sub-clinical level [2].

This paper gives a short overview of the application and health effects on humans of the PGE (Platinum Group Elements) [3,4,5].

References:

[1] Zientek , M.L., and Loferski, P.J., (2014): Platinum-group elements—So many excellent properties: U.S. Geological Survey Fact Sheet 2014–3064, 2 p., https://dx.doi.org/10.3133/fs20143064. ISSN 2327-6932 (online)

[2] Wiseman CL, Zereini F., (2009): Airborne particulate matter, platinum group elements and human health: a review of recent evidence, Sci Total Environ., Apr 1; 407(8): pp. 2493-500.

[3] Yajun Wang Xiaozheng Li, (2012): Health Risk of Platinum Group Elements from Automobile Catalysts, Procedia Engineering, Volume 45, 2012, pp. 1004-1009.

[4] Ravindra K, Bencs L, Van Grieken R., (2004): Platinum group elements in the environment and their health risk, Sci Total Environ. , Jan 5; 318 (1-3): pp. 1-43.

[5] Raymond D. Harbison, Marie M. Bourgeois, Giffe T. Johnson, (2015): Hamilton and Hardy's Industrial Toxicology, 6th Edition, Wiley, May 2015, 1376 pages.

POSTER PRESENTATIONS

Rare Earth Elements (REE) distribution during river – sea waters mixing processes in an estuary affected by acid mine drainage: ecotoxicological implications.

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Abstract

Recently, the demand of rare earth elements (REE) for technological developments has grown and thus, the subsequent releases from industrial wastewater [1, 2]. Anthropogenic activities such as mining can also be a source of these elements to the environment. This is the case of acid mine drainage (AMD) processes originated in sulfide mining, which enhance dissolution of these elements from the host rocks. The strongly-affected-by-AMD Odiel River (SW Spain) transports huge amounts of metalpolluted materials to the Ria of Huelva estuary and the Gulf of Cádiz [3]. In estuaries affected by AMD, salt-induced adsorption/desorption processes are altered by pH variations [4], which may modify the metal partitioning between dissolved and particulate phases. This work studies the fate of REE during the mixing processes occurred naturally in the Ria of Huelva estuary. To accomplish this, laboratory experiments reproducing these mixing processes were performed. Furthermore, field water samples along the mixing zone (pH-gradient 3 to 7) were analyzed for determining REE concentrations, by ICP-MS. Results evidence a pH-mediated transference of REE from the dissolved to the particulate phase, leading to potential toxic effects on the benthic living organisms.

References:

[1] Pagano, G., Guida, M., Tommasi, F., Oral, R., (2015) Health effects and toxicity mechanisms of rare earth elements—Knowledge gaps and research prospects. Ecotoxicology and environmental safety 115:40-48

[2] Oral, R., Bustamante, P., Warnau, M., D'Ambra, A., Guida, M., Pagano, G., (2010) Cytogenetic and developmental toxicity of cerium and lanthanum to sea urchin embryos. Chemosphere 81(2):194-198

[3] Nieto, J.M., Sarmiento, A.M., Canovas, C.R., Olias, M., Ayora, C., (2013) Acid mine drainage in the Iberian Pyrite Belt: 1. Hydrochemical characteristics and pollutant load of the Tinto and Odiel rivers. Environmental Science and Pollution Research 20(11):7509-7519

[4] Achterberg, E.P., Herzl, V.M., Braungardt, C.B., Millward, G.E., (2003) Metal behaviour in an estuary polluted by acid mine drainage: the role of particulate matter. Environmental Pollution 121(2):283-292

Carrot geographical and agricultural practices differentiation using TCE and chemometrics

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Abstract

In this study 103 carrots samples were analyzed from isotopic and multielemental point of view. In total, 47 descriptors were measured, and the obtained results were further processed using analysis of variance (ANOVA), Pearson correlation and linear discriminant analysis (LDA). For the first objective of this study, identification of agricultural type applied for growing, ANOVA reduced the number of descriptors to: ¹⁵N/¹⁴N (0.001), Ti (0.014), Cr (0.002), Mn (0.003), Fe (0.039), Ga (0.025), Sb (0.003), Ba (0.013), Sc (0.031), La (0.001), Ce (0.004), Pr (0.002), Nd (0.005), Yb (0.043), Lu (0.012), Tm (0.005), Th (0.018). Some of these elements, Ti, Sb and Lu, were established by previously published papers that are able to differentiate organically and conventionally grown onion samples (Gundersen et al., 2000). Starting from the information that, between manganese oxides and rare earth elements there is a direct relationship (Pung, Li & Peng, 2001) we used Pearson correlation in order to investigate is such a dependency exists. Our obtained results confirmed the above mentioned information and it was found that both Mn and Cr were correlated with some TCE (La, Ce, Pr, Nd, Lu). By applying LDA on significant descriptors obtained from ANOVA, a percent of 83.3 % and 81 % from initial and cross validation procedure was obtained, using Mn along with La and Ga.

For geographical markers identification, first the sample set was divided according to Transylvania or foreign groups, while in the second case only sample from Transylvania were retained and three distinct areas were compared (Cluj, Salaj and Bihor). For the first comparison, ANOVA reduced the number of variables to Ti (0.001), Cr (0.001), Mn (0.001), Ga (0.001), Sb (0.014), Cs (0.010), Ba (0.035), Tb (0.006) and Pb (0.049). LDA retained only Mn and Tb as discrimination markers, and the percents for initial and cross validation procedures were lower (75.7 % for both classification). The last comparison between Transylvanian areas was characterized by Ti (0.044), δ^{18} O (0.041) and δ^{2} H (0.003), and after applying LDA only δ^{2} H remained as significant marker. The percent were lower because these areas are much closer together and the climatic conditions are the same and it was observed that all samples from Cluj overlapped Salaj area.

References:

[1]Gundersen V., Bechmann I. E., Behrens A., & Strurup S. (2000). Comparative investigation of concentrations of major and trace elements in organic and conventional Danish Agricultural crops. 1. Onions (*Allium cepa* Hysam) and Peas (*Pisum sativum* Ping Pong). Journal of Agricultural and Food Chemistry, 48, 6094 - 6102.

[2]Pang, X., Li, D., & Peng, A. (2001). Application of rare-earth Elements in the Agriculture of China and its Environmental Behavior in Soil. Journal of Soils and Sediments, 1(2), 124-129.

Assessment of the chemical degradation of cytostatic platinum compounds in urine by HILIC-ICP-MS

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Abstract

In the treatment of cancer by chemotherapy, cytostatic platinum compounds (CPC) have a primary role in inhibiting the growth of tumor cells. Three different compounds are currently in use, cisplatin, carboplatin and oxaliplatin, and intravenously administered to cancer patients. Cisplatin is dissolved in an infusion that is buffered with 9 g L⁻¹ NaCl, whereas carboplatin and oxaliplatin are buffered in 50 g L⁻¹ glucose. The drug intake needs to be followed by a short systemic exposure to limit the circumstantial cytotoxicity. Namely, the risk of oto- and nephrotoxicity decreases by a rapid renal clearance, induced by mannitol. So, most residual CPC are cleared from the human body through urinary excretion. Following, the urine is typically diluted and mixed with other flows of wastewater. These changes in aquatic composition will also impact the stability of CPC. Reactions such as the dissociation or exchange of ligands, oxidation to Pt(IV), association to (bio)molecules and further association into colloids can occur and will hence determine the residual toxicity of the drugs in the aquatic environment. To study these changes in speciation, the chemical degradation of CPC in urine is clarified.

Solid substances of cisplatin, carboplatin and oxaliplatin were first dissolved in ultrapure water and consequently spiked to human urine at a platinum concentration of 0.5 mg L⁻¹. Each solution was kept in a thermostatic bath at 37 °C and sub-samples taken out immediately and after 1, 2, 4, 6, 8, 24 and 69 h for filtration over 0.45 µm pore size filters. The platinum speciation was determined by means of Hydrophilic Interaction Liquid Ion Chromatography (HILIC) on a HPLC system coupled to ICP-MS [1]. A volume of 5 µL was injected in a packed Discovery[®] HS F5 column and eluted with 10 mM ammonium acetate in 2 % MeOH. ICP-MS detected the ¹⁹⁵Pt intensity. Calibration was done by linear, least-squares regression of the surface area with mixed external standards ranging from 20 to 1000 µg Pt L⁻¹ concentration.

The resulting data gives the original and unmodified fraction of CPC as a function of time. Regression could successfully fit the data (p < 0.01) to an exponential equation in the case of oxaliplatin and cisplatin, while carboplatin followed a linear trend. It is seen that the decay of oxaliplatin is fastest ($k_1 = 0.158 \pm 0.007 \text{ h}^{-1}$), followed by cisplatin ($k_1 = 0.12 \pm 0.03 \text{ h}^{-1}$). Carboplatin, however, remains highly stable and only started to show degradation after 24 h. The findings assist in assessing the residual (eco-)toxicity of CPC in urine and entering wastewater after usage in medical treatments.

Reference:

[1] Hann, S., Stefánka, Z., Lenz, K., Stingeder, G. (2005): Novel separation method for highly sensitive speciation of cancerostatic platinum compounds by HPLC-ICP-MS, Analytical and Bioanalytical Chemistry, 381, 405-412.

Tellurium (Te) and Selenium (Se) reactivity in estuarine gradients and bioaccumulation in wild oysters

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Abstract

Tellurium (Te) is a Technology Critical Element (TCE) whose biogeochemical behaviour in fluvial-estuarine systems and organisms is widely unknown, mainly due to its ultra-trace environmental concentrations (lacking analytical quantification methods). Contrarily, the biogeochemical cycle of selenium (Se) in estuaries and other environments are well-known, Se being an essential element (toxic in high concentrations) to organisms and human beings. Given the lack of Te environmental studies, it is often assumed that both Te and Se show similar biogeochemical behaviours because of their respective positions in the periodic table of elements. The aim of this study is to explore and compare the behaviour of Te and Se in estuarine environments with respect to partitioning, reactivity and bioaccumulation in wild oysters.

For this we have conducted comparative 48h sorption kinetics experiments, representing estuarine salinity and turbidity gradients, for which we have experimentally determined partition coefficients (Kd) for Te and Se. These coefficients were then applied to estuarine particulate Te (Te_p) and Se (Se_p) concentrations in suspended particulate matter of the Gironde Estuary to estimate the corresponding dissolved concentrations (Te_d, Se_d). Furthermore, we have quantified soft tissue Te and Se concentrations in wild oysters from the Gironde Estuary mouth and from two other coastal sites (i.e., the Arcachon Bay in France and Arriluze in Spain, N = 10 individuals per site) for comparison. The organotropism, i.e. the Te and Se distribution within the different oyster organs, was assessed for a pool of N = 5 individuals from the Gironde Estuary.

Based on Te_p (~0.06 mg kg⁻¹) and Se_p (~0.36 mg kg⁻¹) combined with the experimentally determined Kd values (log₁₀ Kd Te ~ 5.0 I kg⁻¹; log₁₀ Kd Se ~ 2.7 I kg⁻¹), respective estimated Te_d ~ 1 ng l⁻¹ and Se_d ~ 800 ng l⁻¹. Oysters from the Gironde Estuary accumulate clearly higher Se concentrations (~3340 ± 760 µg kg⁻¹ DW, of which ~50% is present in the digestive gland) than oysters from the other sites (~1700 µg kg⁻¹ DW). Tellurium concentrations in oysters (~1.5 µg kg⁻¹ DW, ~70% in the digestive gland) were lower and relatively similar at the different sites. Estimated bioaccumulation factors (BAF) differed by a factor 3 between Te (~1500) and Se (~4500). Although the absolute concentrations of Te and Se in estuarine oysters and particles/Kd values respectively differ by three and two orders of magnitude, their (relatively) similar BAF values may support comparable bio-uptake by oysters.

Accumulation and localization of rare earth elements in ferns

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Abstract

The widespread use of rare earth elements (REE) in various domains, associated with their low level of recycling, results in the continuous increase of REE enrichment around the world. Toxicological effects of these new emerging contaminants have been shown in the recent years, therefore pinpointing the problem raised by their transfer to various ecosystems. Environmentally friendly phytoremediation solutions such as phyto-extraction could remediate high REE contents in soils through the use of REE-accumulating plants. A few number of plant species can accumulate REE in their tissues as high as 3,000 μ g.g⁻¹, among which almost exclusively fern species.

Consequently, up to sixty fern species belonging to distinct genera were exposed to a REEenriched soil (La, Ce, Sm, Gd, Yb, & Y) in order to investigate their potential to accumulate REE. Different accumulation patterns were observed when comparing ferns belonging to different genera but also for various species within a given genus.

Additionally, discrepancies were recorded concerning the uptake of light *versus* heavy REE. Preliminary μ -XRF scans were obtained from *Dryopteris erythrosora* fronds, a species that displayed high REE accumulation compared to other ferns. This analysis provided interesting elemental distribution and revealed different localization patterns for the different REE species.

Bioaccumulation of rhodium nanoparticles in plants – different aspects of sample preparation

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Abstract

Unique properties of rhodium have been used in a variety of industries over the last decades. So far, the main consumer of Rh is the automotive industry, which uses its excellent catalytic properties to produce catalytic exhaust gas converters. Nowadays nanoparticles of the precious metals are used instead of larger particles, which significantly reduce the amount of an element essential to produce the catalyst, and thus the production costs. Due to the increasing use of platinum group elements, the emission of these metals into the environment is increasing at the same time. Over the last decade, PGEs content have been tested in environmental samples such as soil, surface water, street dust, river sediments. So far, there is little information on the uptake of rhodium compounds by plants and its accumulation in plant tissues, especially when nanoparticles of this element are considered. While data concerning bioaccumulation of other nanoparticles show that they could be taken up by plants, transported to above ground organs and influence plant growth. Due to the fact that solubilization of Rh is a difficult task, the aim of the work was to optimize the procedure of plant material digestion enabling quantitative determination of the element. The efficiency of nanoparticle digestion in closed and open systems was compared, in the presence of plant matrix as well as in its absence. Conventional and microwave heating was applied. Determination of Rh was carried out by independent analytical methods – adsorptive stripping voltammetry (AdSV), inductively coupled plasma mass spectrometry (ICPMS) and transmission electron microscopy (TEM).

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Thallium accumulation in the liver and gills of brown trout (*Salmo trutta* L., 1758) from the Croatian river Krka

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Abstract

Nowadays, there is an increasing demand for TI in the high-technology and future-technology fields. Due to its toxicity even at very low concentrations, high water solubility, mobility, and tendency to bioaccumulate in living organisms, TI was included in the list of priority pollutants by the US Environmental Protection Agency [1] and should be regularly monitored in the natural waters and organisms [2].

The aim of this study was to obtain the information on TI bioaccumulation level in the liver and gills of brown trout (S. trutta L., 1758) caught at two sampling points at the Krka River (river spring as a reference site and location downstream of Knin town as a contaminated site) in two seasons (October 2015 and May 2016). Measurements were performed in the cytosolic fractions using high resolution inductively coupled plasma mass spectrometer. Thallium concentrations in the hepatic cytosol were on average seven times higher compared to the gill cytosol. However, in both organs cytosolic TI concentrations were significantly higher at the reference site in autumn and spring, respectively (liver: 228.4 and 306.2 ng g⁻¹; gills: 16.7 and 18.6 ng g⁻¹) compared to location downstream of Knin town (liver: 82.5 and 130.6 ng g^{-1} ; gills: 5.4 and 7.8 ng g^{-1}). This finding could not be explained by exposure in the water, since at both sites TI was present in the river water in very low and comparable concentrations (4-5 ng L⁻¹) [3]. The assessment of possible influence of fish physiology on TI bioaccumulation revealed that there was no significant association between TI concentrations in the liver and gills of brown trout and fish mass or sex. Therefore, higher TI bioaccumulation at the reference site in both studied organs of brown trout in both seasons indicated higher TI exposure at that site, possibly through diet and due to sediment contamination with TI, which should be further investigated. Considering that there are no known sources of pollution at the Krka River spring, TI at that site probably originates from natural sources.

References:

 Das A.K., Chakraborty, R., Cervera, M.L., Guardia, M.D. (2006): Determination of thallium in biological samples, Analytical and Bioanalytical Chemistry 385, 665-670.
 Peter, A.L., Viraraghavan, T. (2005): Thallium: a review of public health and environmental concerns, Environment International 31, 493-501.

[3] Dragun, Z., Filipović Marijić, V., Krasnići, N., et al. (2017): Total and cytosolic concentrations of twenty metals/metalloids in the liver of brown trout *Salmo trutta* (Linnaeus, 1758) from the karstic Croatian river Krka, Ecotoxicology and Environmental Safety 147, 537-549.

Rare Earth Elements in the Moselle River upstream of Nancy, France

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Abstract

Rare Earth Elements (REEs) have wide and growing applications in high efficiency electronics, energy technologies and/or medical applications. These anthropogenic uses already disrupted the biological cycle of REEs, and lead to enrichments of La, Ce, Sm, and Gd in waters. One of the main pathways for the anthropic REEs to enter in the aquatic systems is effluent from urban wastewater treatment plants (WWTPs). Some of those REEs are not eliminated by conventional WWTPs practices, notably anthropic Gd. Hence, the concentration of some REEs measured close to WWTP effluent discharge points can be high enough to elicit effects on aquatic systems^[1]. The presence of REE in sewage may also affect some aspect of treatment efficiency within WWTPs, particularly on the microbiological part^[2]. Knowledge of the REE mixtures, abundances and distribution in WWTP and receiving waters is therefore necessary to guide further ecotoxicological research on their combined effects in the environment as well as in relation to water treatment efficiency.

Grand Nancy is a 320,000 inhabitant's agglomeration using the Moselle River for drinking water production. Presence of REEs in the surface water between the river source and the water intake facilities and in the drinking water was investigated to see if potential REEs anomalies can be detected in those waters and, where appropriate, can end up in the WWTP influent. Sample campaigns were also performed at the inlet of the Grand Nancy WWTP. They showed that there is a Gd positive anomaly in wastewater, and that other REEs anomalies can be observed in the influent, but less high and more variable (not for the same REEs according to sample campaigns).

References:

[1] González V, Vignati DAL, Pons M-N, Montarges-Pelletier E, Bojic C, Giamberini L. 2015. Lanthanide ecotoxicity: First attempt to measure environmental risk for aquatic organisms. Environmental Pollution. 199(0):139-147

[2] Fujita Y, Barnes J, Eslamimanesh A, Lencka MM, Anderko A, Riman RE, Navrotsky A. 2015. Effects of simulated rare earth recycling wastewaters on biological nitrification. Environ Sci Technol.

Ecotoxicological evaluation of TCEs potentially released by dismissed photovoltaic panels

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Abstract

Recently the potential environmental hazard of photovoltaic (PV) modules together with their management as waste has attracted the attention of scientists. Particular concern is aroused by the several metals contained in PV panels, whose potential release in the environment, if not correctly confined in landfill, was scarcely investigated. Actually only few experimental studies about the end-life PV panels emissions and the relative environmental consequences were reported in literature (Berger, 2010; Raugei, 2009). In particular Tammaro et al. (2016) reported, for the first time, a realistic scenario based on experimental measurements of metal released by PV modules. Although PV panels contain several metals classified as hazardous, the investigations mainly concerned the presence of cadmium in Thin Film (TF) module, and of lead and chromium in Crystalline silicon (c-Si) modules, while the potential toxicity of technology critical elements (TCEs), such as Ga, Te and In, also present in the PV technologies, was still scarcely investigated. Generally, in c-Si panels leacheate only low concentration of Te has been detected, while Ga and In were totally absent. In TF panels, instead, all the chemical species considered were detected, in particular for Te a very high concentration has been found.

In this work we would focus on the potential environmental hazard associated with the release of TCEs from dismissed PV panels, by evaluating the ecotoxicological effects. In particular an ecological relevant toxicity test battery was chosen: the growth inhibition with *Pseudokirchneriella subcapitata*, the bioluminescence inhibition with *Vibrio fischeri* and the evaluation of mortality with *Daphnia magna*. Among test organisms, algae, very often in the case of PV crystalline technology and always in the case of TF technology, resulted the most sensitive in the identification of the toxicity and often was the only test organism that evidenced the toxicity.

Additionally, with the aim to individuate a threshold level of ecotoxicological risk, literature data were also collected and integrated into unique synthetic index using different approaches of toxicity data integration.

Moreover, to better understand the next environmental potential impact, the assessment of the PV releasable amounts, minimum and maximum, of Ga, Te and In was performed.

In conclusion it could be evidenced that, in the future, a possible increase of these elements occur in the aquatic environment provoking possible adverse effects upon biota. This estimation leads to the need of continuous assessment of these TCEs in the environment and to urgently define their regulatory limits.

References:

Tammaro, M., Salluzzo, A., Rimauro, J., Schiavo, S., Manzo, S., (2016): Experimental investigation to evaluate the potential environmental hazards of photovoltaic panels, Journal of hazardous materials 306 395-405

Berger, W., (2010): A novel approach for the recycling on thin film photovoltaic modules Resour. Conserv. Recycl. 54 , pp. 711-718

Raugei, M., (2009): Prospective analysis of the future impact of CdTe PV in terms of Cd demand and Cd emissions23rd European Photovolt. Sol. Energy Conference, 21–25. Sept., Hamburg,T yskland pp. 3080-3083

Vegetables characterization using light stable isotope ratios and multi-element analysis as geochemical markers

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Abstract

The consumers demands for organic food has significantly increased during the last years. Thus, the number of organic producers and the area of organically cultivated land are continuously increasing. Consequently, the labeling of some conventionally obtained vegetables to pass as organic through illegitimate activities for economic profit are very popular, since the prices of these products can vary greatly. This study proposed the association of isotopic markers ($\delta^{13}C$, $\delta^{2}H$, and δ^{18} O) with multi-element analysis. The corroboration of these markers was made using chemometric processing for differentiation of organic vegetable types (salad, tomatoes, potatoes, cabbages and hot peppers) from vegetables obtained through conventional agricultural practices. For the differentiation of organic vegetables from those grown under conventional practices, LDA data processing was applied using all experimental data obtained for entire investigated vegetables set. The two groups were initially correct classified in percent of 84.4 % followed by a similar crossvalidation percent. In order to a better distinguishing of the two product types (organic vs. conventional), a splitting of the samples in two groups was made, accordingly vegetables types: subterranean and above-ground plants. In this case, a differentiation of organic samples in a percent of 100 % for subterranean vegetables was obtained while, for above-ground plants a separation of 92.9 % was archived.

References:

[1] Laursen, K.H., Mihailova, A., Kelly, S.D., Epov, V.N., Bérail, S., Schjoerring, J.K., Donard, O.F.X., Larsen, E.H., Pedentchouk, N., Marca-Bell, A.D., Halekoh, U., Olesen, J.E., Husted, S., (2013): Is it really organic? – Multi-isotopic analysis as a tool to discriminate between organic and conventional plants, Food Chemistry 141, 2812-2820.

[2] Laursen, K.H., Schjoerring, J.K., Kelly, S.D., Husted, S., (2014): Authentication of organically grown plants – advantages and limitations of atomic spectroscopy for multielement and stable isotope analysis, Trends in Analytical Chemistry 59, 73-82.

[3] De Rijke, E., Schoorl, J. C., Cerli, C., Vonhof, H. B., Verdegaal, S. J. A., Vivó-Truyols, G., Lopatka, M., Dekter, R., Bakker, D., Sjerps, M. J., Ebskamp, M., de Koster, C. G., (2016): The use of δ^2 H and δ^{18} O isotopic analyses combined with chemometrics as a traceability tool for the geographical origin of bell peppers, Food Chemistry 204, 122 – 128.

Thallium bioaccumulation in different bioindicator organisms from the karst Krka River in Croatia

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Abstract

Metals present one of the major threats for aquatic systems due to their persistence, toxicity and potential to bioaccumulate in organisms. Naturally present trace metal concentrations in karst rivers are low which makes them very sensitive to anthropogenic influence. Krka River is a typical karst river in the Republic of Croatia whose lower part was proclaimed National Park. However, it is nowadays threatened by municipal and industrial wastewaters near the park border. The aim of this study was to evaluate TI bioaccumulation in acanthocephalans, fish intestinal parasites known by their effective metal accumulation, and in species involved in their life cycle, fish and crustaceans, from two sampling locations (river source as a reference, and downstream of wastewater inputs as a polluted site) in autumn and spring.

Thallium is a rare heavy metal but its high toxicity, water solubility and tendency of bioaccumulation made it a US EPA priority pollutant. It is released from both natural and anthropogenic sources. While generally present in the environment at low levels; human impact has greatly increased its content [1].

HR ICP-MS was used to measure TI concentrations in samples of digested acanthocephalans, gammarids and intestinal and muscle tissue of brown trouts, as well as in water samples. In both seasons, TI concentrations were comparable in crustaceans and fish intestine, but these levels were 2-4 times higher than in muscle, although all followed the same pattern with 2-3 times higher levels in the reference compared to the polluted site. The same pattern was observed in acanthocephalans, but TI levels were around 30 times higher than in gammarids and fish intestine and around 100 times higher than in fish muscle, therefore confirming effective TI accumulation. Such results are not in accordance with TI concentrations in river water, which were very low and comparable between sites (4-5 ng L⁻¹) [2]. Thus, obvious higher TI exposure at the reference site needs strict monitoring and further investigation of potential TI sources, dietborne exposure and sediment content.

References:

[1] Karbowska, B. (2016): Presence of thallium in the environment: sources of contaminations, distribution and monitoring methods, Environmental Monitoring and Assessment 188, 640

[2] Filipović Marijić, V., Kapetanović, D., Dragun. Z., et al. (2017): Influence of technological and municipal wastewaters on vulnerable karst riverine system, Krka River in Croatia, Environmental Science and Pollution Research, doi 10.1007/s11356-017-0789-1.

PGEs accumulation and biochemical responses in bivalves

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Abstract

The increased use of platinum group elements (PGEs) in a variety of human activities has led to a concern over their environmental impact and biological accumulation [1]. To reduce the emission of contaminant gases from motor vehicles, the automobile industry coupled with oil producers invested in the development of a system to diminish this global pollution. As a result, catalytic converters were developed to improve the yield of gasoline combustion in motor vehicles and also lead to the elimination of Pb as an additive. These converters use platinum (Pt), palladium (Pd) and rhodium (Rh), among other elements that are spread to the environment. The increased release of the PGEs into various environmental compartments is taking place, and their current importance is critical to define the state of knowledge and gaps. Thus, the paradigm of the environmental impact of PGEs is changing rapidly. There are few data on the PGEs concentrations in organisms under natural conditions (e.g. [2 - 3]), being most of the studies performed in laboratory (e.g. [4 - 5]). Basic knowledge of PGEs levels in animal tissues and their toxicity is essential to evaluate the potential risk of environmental contamination.

Once exposed to contaminants, organisms will attempt to regain homeostasis through the generalized stress response, contaminant transport, and metabolism, leading to the development of elimination / detoxification mechanisms. This mechanisms may involve specific and soluble ligands, namely proteins ([6] and [7]). The relationship between metal accumulation and protein synthesis, especially metallothioneins, has been widely described for the animal kingdom ([8] and [9]). Metal-binding proteins also play an important role in physiology, performing other functions including homeostatic regulation, accumulation, transport and storage of oxygen, and regulation of gene expression [10]. This study is novel and will follow a logical and hierarchical approach to address the concentrations and effects of PGEs in wild estuarine bivalves, manila clam (*Ruditapes philipinarum*) and peppery furrow (*Scorbicularia plana*) from the Tagus and Sado estuaries.

References:

[1] Neira et al., 2015. Science of the Total Environment 514, 366-370; [2] Jensen et al., 2002. Archives of Environmental Contamination and Toxicology 42, 338-347; [3] Ek et al, 2004. Science of the Total Environment 334-335, 21-38; [4] Zimmerman et al., 2004. Environmental Science and Pollution Research 11, 194-199; [5] Osterauer et al., 2009. Chemosphere 77, 975-982; [6] Viarengo, A., 1989. Heavy metals in marine invertebrates. Mechanisms of regulation and toxicity at the cellular level. Review Aquatic Science, 1: 295-317; [7] Roesijadi, G., 1992. Metallothioneins in metal regulation and toxicity in aquatic animals. Aquatic Toxicology, 22: 81-114; [8] Viarengo, A. e Nott, J., 1993. Mechanisms of heavy metal cátion homeostasis in marine invertebrate. Comparative Biochemistry and Physiology, 67C: 215-218; [9] Roesijadi, G. 1996. Metallothionein and its role in toxic metal regulation. Comparative Biochemistry and Physiology, 67C: 215-218; [9] Roesijadi, G. 1996. Metallothionein and its role in toxic metal regulation. Comparative Biochemistry and Physiology, 67C: 215-218; [9] Roesijadi, G. 1996. Metallothionein and its role in toxic metal regulation. Comparative Biochemistry and Physiology, 67C: 215-218; [9] Roesijadi, G. 1996. Metallothionein and its role in toxic metal regulation. Comparative Biochemistry and Physiology, 67C: 215-218; [9] Roesijadi, G. 1996. Metallothionein and its role in toxic metal regulation. Comparative Biochemistry and Physiology, 113C: 117-123; [10] Stutz, H.; Bordin, G. e Rodriguez, A., 2003. Separation of selected metal-binding proteins with capillary zone electrophoresis. Analytica Chimica Acta, 477: 1-19.

TCEs in waters and sewage sludges from a WWTP from Santiago de Compostela (northwestern Spain)

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Abstract

After their release to the environment, TECS can accumulate in the sludges of the water treatment plants with the subsequent risk if those materials are used as soil fertilizers. The objective of this study is the analysis of TECS in water and sewage sludges taken from a WWTP from Santiago de Compostela, Northwestern Spain, to evaluate the current situation in our region.

Total concentration of the elements was determined in the samples after a microwave assisted acid digestion with nitric acid and hydrogen peroxide (for water treatment), or nitric acid and sulfuric acid in the case of sewage sludges. Inductively coupled plasma-mass spectrometry (ICP-MS) was the technique used to perform the analysis.

The analytical characteristics of the method (limits of detection, analytical recovery, reproducibility...) were also evaluated.

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Elemental profile of Lactuca sativa plant and toxicological effect of contaminated water to evaluate human exposure

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Abstract

The evaluation of human exposure to TCEs can be done directly (air inhalation, soil ingestion or dermal absorption) or indirectly mainly through water or food. The uptake of elements in plants is affected by the plant species, plant maturity or agricultural practices. Multielemental content of *Lactuca sativa* plant was monitored in order to identify the optimal harvest period of plant, from the maximum nutritional point of view. Technological critical elements were identified in different stages of growth and the obtained experimental data were processed with different chemometric techniques.

In order to evaluate the human exposure to TCEs through water consume, specific quatities of water were contaminated with different known amounts of TCEs (silver oxide, rhutenium complex, indium oxide). As literature shows different rhutenium complexes are nowadays used in medicine for oncological problems. Acute and chronic toxicity was evaluated on rats. Further toxicity evaluation is expected to be carried out in contamined milk, fruit juice or medicinal herb extracts to provide a better map of human exposure to TCEs through food.

References:

[1] Grozav, A., Miclaus, V., Vostinaru, O., Ghibu, S., Berce, C., Rotar, I., Mogosan, C., Therriene, B., Loghin, F.,Popa, D.S., (2016): Acute toxicity evaluation of a thiazolo arene rhutenium (II) complex in rats, Regulatory Toxicology and Pharmacology 80, 233-240.

[2] Pinto, E., Almeida, A.A., Aguiar, A.R.M., Ferreira, M.P.L.V.O., (2014) Changes in macrominerals, trace elements and pigments content during lettuce (*Lactuca sativa L.*) growth: Influence of soil composition, Food Chem 152, 603-611.

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