SEGH Society for Environmental Geochemistry and Health

Organiser:
HELLENIC REPUBLIC
National and Kapodistrian University of Athens
EST. 1837
Department of Geology and Geoenvironment

# SEGH2023

## 38th International Conference on Geochemistry and Health

www.segh2023.org

2-6 July 2023

Athens
Greece

# BOOK OF ABSTRACTS

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# Welcome Address

The Society for Environmental Geochemistry and Health and the Department of Geology and Geoenvironment of the National and Kapodistrian University of Athens invite you in Europe and the 38th International Conference on Environmental Geochemistry and Health.

This key SEGH annual event will provide the opportunity for experienced and more junior researchers and students to promote their own work and interact in person with peers and knowledgeable colleagues. The SEGH 2023 themes will focus on:

- Emerging contaminants and human health in land, water, and air
- Innovative data collection methods for studying environmental change
- Environmental geochemistry in the energy transition era
- Global databases for geochemistry and beyond

Athens, a metropolis of Southeast Europe, provides excellent opportunities to explore history, culture and a beautiful Mediterranean environment. Our social program will make the most out of the Athens surroundings, highlighting the geosites of the Acropolis of the ancient city as well as the Athens riviera.

**Prof. Ariadne Argyraki**
Organizing Committee Chair
National Kapodistrian University of Athens (NKUA)

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SEGH Society for Environmental Geochemistry and Health

# You are Welcome to 39th SEGH Conference

## 'Nigeria 2024'

**Expected Conference programme.**

- Pre-Conference workshops
- Ice Breaker
- Keynote and Plenary Lectures/Talks
- Technical Presentations
- ECR Lunch and Mentoring Sessions
- Fellows Lunch Meeting
- Conference Dinner
- Guarded City Tour
- Post Conference Excursions

(www.segh.net)

# ACKNOWLEDGEMENTS

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# PROGRAMME OVERVIEW

## Monday, July 3rd, 2023

| | |
|---|---|
| 8:00 | Registration Opens |
| 08:45 - 09:10 | Welcome and Introduction |
| **SESSION 1** | **EMERGING CONTAMINANTS AND HUMAN HEALTH (Part I)** |
| 09:10 - 09:15 | Industry Presentation |
| 09:15 - 09:45 | Keynote Talk - Nikos Thomaidis |
| 09:45 - 10:45 | Platform presentations |
| 10:45 - 11:05 | Break Poster viewing Sponsor exhibition |
| 11:05 - 13:00 | Platform presentations |
| 13:00 - 14:00 | Lunch Poster viewing Sponsor exhibition |
| **SESSION 2** | **EMERGING CONTAMINANTS AND HUMAN HEALTH (Part II)** |
| 14:00 - 15:10 | Platform presentations |
| 15:10 - 15:30 | Break Poster viewing Sponsor exhibition |
| 15:30 - 16:30 | Platform presentations |
| 16:30 - 18:30 | SEGH Fellows meeting / Poster viewing Sponsor exhibition |
| 19:30 - 21:00 | Acropolis Geotour |

## Tuesday, July 4th, 2023

| | |
|---|---|
| 09:00 - 09:15 | Welcome and Introduction 10 MIN / Sponsor presentation 5 MIN |
| **SESSION 3** | **INNOVATIVE DATA COLLECTION METHODS AND ENVIRONMENTAL CHANGE** |
| 09:15 - 09:45 | Keynote Talk - Jane Entwistle |
| 09:45 - 10:50 | Platform presentations |
| 10:50 - 11:10 | Break Poster viewing Sponsor exhibition |
| 11:10 -12:45 | Platform presentations |
| 12:45 - 13:45 | Lunch Poster viewing Sponsor exhibition |
| **SESSION 3** | **INNOVATIVE DATA COLLECTION METHODS AND ENVIRONMENTAL CHANGE (cont.)** |
| 13:45 - 15:05 | Platform presentations/ Poster flash presentations |
| **SESSION 4** | **GLOBAL DATABASES FOR GEOCHEMISTRY AND BEYOND** |
| 15:05 - 15:35 | Keynote Talk - Alecos Demetriades |
| 15:35 - 15:55 | Break Poster viewing Sponsor exhibition |
| 15:55 - 17:50 | Platform presentations |
| 20:00 - 23:00 | Conference Dinner at **"Nisos Restaurant"** |

## Wednesday, July 5th, 2023

| | |
|---|---|
| 09:00 - 09:15 | Welcome and Introduction |
| **SESSION 5** | **ENVIRONMENTAL GEOCHEMISTRY IN THE ENERGY TRANSISTION ERA** |
| 09:15 - 09:45 | Keynote Talk - Mike Ramsey |
| 09:45 - 10:40 | Platform presentations |
| 10:40 - 11:00 | Break Poster viewing Sponsor exhibition |
| 11:00 - 12:40 | Platform presentations |
| 12:40 - 13:40 | Lunch Poster viewing Sponsor exhibition |
| **SESSION 6** | NEXUS MONARC workshop |
| 13:40 - 16:10 | NEXUS MONARC workshop on diversity, inclusion and integrity in research and academia. |
| 16:15-16:45 | Closing ceremony, prize giving & SEGH AGM (all delegates) |
| 17:00 | Departure to Methana (optional field trip) / or free evening |

# CONFERENCE SESSION THEMES

## Sessions 1 & 2

**EMERGING CONTAMINANTS AND HUMAN HEALTH**

Emerging contaminants, i.e. substances which are not yet regulated but may be of environmental or human health concern, include medicines, personal care products and industrial compounds. These emerging contaminants not only impair soil quality and freshwater sources but could also get into the food chain and affect human and animal health. We present contributions advancing the understanding of interaction between emergent contaminants, the geoenvironment and human health.

## Session 3

INNOVATIVE DATA COLLECTION METHODS AND ENVIRONMENTAL CHANGE

Technological developments in collection and analysis of geospatial data include the use of geographic information systems (GIS) and imagery analysis, crowdsourcing, and mobile technology. These new methods are applied on their own or in combination with traditional data collection systems such as household surveys, censuses, and administrative data. We are presenting abstracts that showcase novel data collection methods to solve complex environmental challenges and assess environmental change.

## Session 4

**GLOBAL DATABASES FOR GEOCHEMISTY AND BEYOND**

Our era is characterized by a growing rate of data generation. Additionally, current research data management practices require that global databases need to meet principles of findability, accessibility, interoperability, and reusability (FAIR). Abstracts demonstrating examples of generating standardized data and machine-readable metadata as well as utilization of such databases for answering geochemical and environmental questions are being presented.

## Session 5

**ENVIRONMENTAL GEOCHEMISTRY AND ENERGY TRANSITION ERA**

Utilisation of critical elements, which are vital for emerging and low-carbon technologies, is often a two-sided question since some of the products and technologies which use such elements, while being developed to reduce environmental impacts require mining and refining that may have environmental consequences. The aim of this theme is to address this dichotomy. We present papers examining all aspects of the life cycling of critical elements with potential toxicity for the terrestrial and marine environments.

# KEYNOTE SPEAKERS

## Session 1 - EMERGING CONTAMINANTS

**Prof. Nikolaos S. Thomaidis**

Professor of Analytical Chemistry at the National and Kapodistrian University of Athens, specializing in Environmental and Food Chemistry. His research interests include the development of cutting-edge HRMS methodologies and workflows for a comprehensive chemical characterization of environmental and biological samples. He has extensive experience in supervising and coordinating research projects with both national and European funding, including the "Development of an intelligent system of epidemiological surveillance and environmental health monitoring" and the "LIFE APEX: systematic use of contaminant data from apex predators and their prey in chemicals management".

### Keynote title

**Monitoring of key environmental indicators to assess human exposure to emerging contaminants**

There is a growing recognition that chemical pollution is an immediate threat to humanity's safety and our planet. A toxic-free environment is within the European ambitions, since in 2017, the EC adopted the EU One Health Action Plan, which recognizes that human, animal and environmental health are interconnected. Humans and wildlife are exposed to mixtures of thousands of chemicals, including pharmaceuticals, pesticides, industrial chemicals, together with numerous transformation products, which pose substantial threat to the ecosystem and raise concerns for the human health. Due to their high trophic position in food webs, apex species are valuable indicators for assessing environmental health. Chemical monitoring data from apex species may reveal compounds with bioaccumulative and persistent properties. Through the implementation of the LIFE APEX project (2018-2022), a first pan-European biomonitoring study using apex predators and prey samples was implemented, revealing the ubiquitous presence of thousands of organic contaminants. An alternative approach for giving insights on human exposure is through wastewater-based epidemiology (WBE). WBE has increased rapidly during the last decade and provides important real-time information about public health, lifestyle habits and exposure to environmental chemicals, through the analysis of untreated wastewater. In a recent proof of concept study, the use of sewage sludge was suggested as a proxy of the human exposure and its application in early warning systems to prevent bioaccumulation of hazardous chemicals, since correlations regarding the profile and concentrations of chemicals were revealed through the analysis of sewage sludge and human biological samples.

Session 3 - **INNOVATION AND ENVIRONMENTAL CHANGE**

**Prof. Jane Entwistle**

Jane's research addresses problems at the interface between geochemistry and human health and evidences her commitment to improve environmental practice, policy and decision making in a complex real-world environment. Her principal focus has been on the bioavailability and bioaccessibility of trace elements in the environment to enhance our understanding of exposures to environmental pollutants and to inform ways to reduce this exposure.

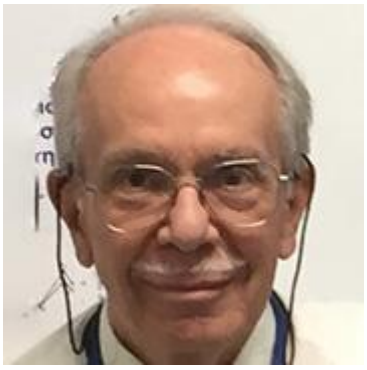
**Keynote title**

**Baseline data on chemicals and microbial communities in regular households via a global citizen science-academic partnership**

Human health and wellbeing are intimately linked to the state of the environment. By 2050 UN projections indicate two thirds of the world's population will live in cities, yet urban areas remain some of the unhealthiest places to live. Opportunities exist through citizen science to engage communities and provide a valuable source of local information which can broaden our understanding and inform interventions. We co-developed a global partnership to explore the indoor exposome via house dust (www.MapMyEnvironment.com) and evaluated trace metal concentrations and health risks in homes from 33 countries, along with a suite of potentially contributary residential characteristics. Increasing home age was associated with greater lead (5 mg/kg per year of house age) and arsenic (0.48 mg/kg per year) concentrations, as were peeling paint, recent renovation and garden access. Indoor dust also serves as a reservoir for environmental exposure to microbial communities yet our knowledge of the spatial heterogeneity of bacterial assemblages in our residential environment remains limited. To investigate the existence of a common core house dust bacterial microbiome we selected household vacuum dusts from homes across two bioclimatic regions (UK, Oceanic/Maritime and Greece, Mediterranean). We identified both a "common to all" core house dust microbiome and a "unique location specific" microbiome. We also conducted shotgun metagenome sequencing to look specifically at one set of human health related indicator functional genes. We targeted antimicrobial resistance (AMR) genes to investigate the distribution, variability and potential for regional variation of this human health related functional gene family. Of the 33 most commonly prescribed antibiotics in the UK, only AMR to 4 (ciprofloxacin, erythromycin, fosfomycin and norfloxacin) were encountered as common in the study. Our study highlights community science as a powerful approach to access the indoor residential environment, at scale, and a mechanism to promote environmental health literacy through engagement activities.

Session 4 - **GLOBAL DATABASES**

**Prof. Alexandros (Alecos) Demetriades**



Alexandros after his MSc degree in Mining Geology and Mineral Exploration worked as an applied geochemist at the Hellenic Institute of Geology and Mineral Exploration, where for over 35 years managed many geochemical survey projects for mineral exploration and environmental contamination purposes. Alecos holds the Chair of the Sampling Committee of the IUGS Commission on Global Geochemical Baselines and is Editor-in-Chief of the recently published *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*. He is co-author of the FOREGS Geochemical Europe of Atlas and the *Geochemical Mapping of Agricultural and Grazing land soil in Europe* (GEMAS), and published over 100 applied geochemistry papers.

## Keynote title

**Standard methods for establishing the global geochemical reference network**

The *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*[1] presents, for the first time, a comprehensive overview of the geochemical methods and procedures that should be employed across the land surface of the Earth to map the distribution of chemical elements in various sample types. As the sampling will cover the whole globe the procedure must be consistent for all sample types and, therefore, is standardised to be applicable in all morphoclimatic environments. It describes in detail all the necessary methods that should be used from planning the sampling campaign2, through sampling of rock, residual soil, humus, stream water, stream sediment, overbank sediment and floodplain sediment; sample preparation; development of project reference materials; analytical methods; quality control3 and assurance procedures for the production of harmonised data sets; data levelling of existing regional geochemical data sets with respect to the established Global Terrestrial Network datum; data conditioning for the production of seamless geochemical maps; data management and map plotting and, finally, to project management. Applying these methods will produce internally consistent quality-controlled data sets for each sampling medium for multipurpose use. Any applied geochemist carrying out a geochemical mapping project at any scale and purpose should find a wealth of useful information within the pages of this Manual.

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[1] **Demetriades, A., Johnson, C.C., Smith, D.B., Ladenberger, A., Adánez Sanjuan, P., Argyraki, A., Stouraiti, C., Caritat, P. de, Knights, K.V., Prieto Rincón, G. and Simubali, G.N. (Editors), 2022.** *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*. **IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 2, 515 pp.** https://doi.org/10.5281/zenodo.7307696.

[2] **He, J. and Geng, X., 2022.** *R-scripts for Generation of 5, 8 and 16 Random Sampling Points Within Predefined Rectangles*. **IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 3, 14 pp.** https://doi.org/10.5281/zenodo.7307202.

3 **Vassiliades, E., 2002.** *Program ROBCOOP4A for Estimation of Balanced Classical and Robust Analysis of Variance: Instructions for Use and Source Code*. **IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, 4, 42 pp.** https://doi.org/10.5281/zenodo.7307388.

Session 5 - **GLOBAL DATABASES / ENVIRONMENTAL GEOCHEMISTRY AND ENERGY TRANSITION**

**Prof. Mike Ramsey**

Mike Ramsey is Emeritus Professor at University of Sussex. After a PhD in Analytical Geochemistry, he conducted research and taught at Imperial College, London for 20 years. He's published over 160 scientific papers, including many on uncertainty of measurement arising from field sampling, and its effects on decision making. Mike is Chair of the Eurachem/Eurolab/CITAC/Nordtest/AMC Working Group on Uncertainty from Sampling, which has published International Guidance on this subject. Broader research included NERC-funded project on Multiple Links Towards Integrating Teams for Understanding of Disease and Environment (2007-2008). Chair of European Section of SEGH 2005-2008

**Keynote title**

**Estimation of measurement uncertainty from sampling at different spatial scales: microns to kilometers**

Measurement uncertainty (MU) has become the key metric with which to express the quality, reliability and suitability of geochemical measurements. Increasing evidence shows that the dominant contribution to MU is often from primary sampling (UfS), rather than from chemical analysis. The method of UfS estimation usually employed is the 'duplicate method', in which duplicate primary samples are taken at locations that are separated by a distance (in space or time) which reflect the ambiguity in the sampling procedure. The heterogeneity of the analyte concentration at the spatial (or temporal) scale of the geochemical survey causes differences in the measurement values for the two duplicate samples and is thereby included in MU. International guidance on how to estimate MU that includes UfS from Eurachem1, and applied by IUGS2, focuses on sampling at the macro-scale (m to Km). Case studies will be discussed where, the duplicate method has been shown to be equally applicable for geochemical investigations at the micron scale, for example within single mineral grains. Other studies of analyte heterogeneity over a range of scales (from mm to m)3, support the idea that these empirical methods of MU/UfS estimation are effective at any spatial (or temporal) scale, if the spatial (or temporal) separation of the distance between the duplicate samples is selected in an appropriate way.

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[1] Ramsey M.H., Ellison S. L. R., and Rostron P.(eds.) (2019) *Eurachem/EUROLAB/ CITAC/Nordtest/* AMC Guide: *Measurement uncertainty arising from sampling: a guide to methods and approach, Second Edition, Eurachem, ISBN 978-0-948926-35-8* http://www.eurachem.org/index.php/publications/guides/musamp Demetriades A, Johnson C.C., Argyraki A.(2022), Quality Control Procedures, Chapter 7 of Demetriades, A., et al., (Editors), 2022. *International Union of Geological Sciences Manual of Standard Methods for Establishing the Global Geochemical Reference Network*. IUGS Commission on Global Geochemical Baselines, Athens, Hellenic Republic, Special Publication, **2**, 515 pp.

[3] Ramsey M.H., Grace Solomon-Wisdom G.O. and Argyraki A. (2013) Evaluation of *in situ* heterogeneity of elements in solids: implications for analytical geochemistry. Geostandards and Geoanalytical Research, 37, 4, 379-391. DOI: 10.1111/j.1751-908X.2013.00236.x

# ORAL PRESENTATIONS

S1-IP01

## Geohellas Presentation

**Konstantinos Vythoulkas**
*Mining Development Manager, Geohellas, Athens, Greece*

Geohellas is the exclusive European source of palygorskite or attapulgite as it is known commercially and natural attapulgite/saponite blends.

Its extensively researched deposits spread across four privately-owned mines (quarries), that are located in the vicinity of the plant between the cities of Grevena and Kozani in west Macedonia, northern Greece.

Geohellas modern, fully automated processing plant is operational since 2004 and has an annual capacity of more than 160,000 MT of products varying from granular to ultrafine powders and with versatile packaging capabilities ranging from big bulk bags to small open mouth type consumer bags and carton boxes.

Processing involves natural drying, pre-crushing, extrusion, crushing, drying/thermal activation, screening/sizing, milling and classification.

The Geohellas team is dedicated to enhancing the performance, efficiency, and output of our customers' products, all the while maintaining strict adherence to hygiene, safety, and environmental protection standards in every aspect of our operations.
Geohellas team is dedicated to responsible mining practices, combined with state-of-the-art methodologies, demonstrating our commitment to sustainable resource extraction activities.

We prioritize environmental protection and contribution to a circular economy & sustainable practice by embracing the power of the sun in the clay drying process, by integrating waste reduction and recycling initiatives and by implementing a comprehensive land restoration program.

Geohellas serves clients in several sectors including industrial absorbents and technical products for environmental applications. Industrial absorbents ABSO-PRO® products, offer effective spill control and spill prevention as well as safe leak containment for spills of diverse origins. MAK® ECO products are used for the purification of wastewater & sludge dewatering as well as in land rehabilitation schemes, offering adsorption and stabilization of heavy metals and other toxic chemicals.

S1-OP01

# Antimicrobial resistance development in environmental microorganisms and its mitigation

**Kiri Rodgers**[1], Fiona Henriquez[1], John Connolly[3], Andrew Hursthouse[1], Suparna Mukherji[3], Soumyo Mukherji[3], Ronnie Mooney[1], Erin Corbett[1]
*[1]University of the West of Scotland, Paisley, United Kingdom, [2]Indian Institute of Technology Bombay, Powai, India, [3]Glasgow Caledonian university*

Antimicrobial resistance (AMR) is a global health and development threat, which requires urgent cross sector action to achieve the UN-Sustainable Development Goals (SDGs). Although AMR is predominantly attributed to the misuse and overprescribing of antibiotics, it is becoming more widely accepted that environmental factors, such as anthropogenic pollutants and microbial community interactions, contribute to AMR prevalence. These factors increase the complexity of this global challenge we face globally, and mitigation strategies that recognize these additional components are of critical importance.
While there is still a wealth of unknowns, and different strategies being implemented in the attempt to monitor and mitigate the global rise of AMR, particularly with regards to identification of key markers, our group seeks to use a 'One Health' approach to tackle this challenge. Our project 'Advanced Metagenomics, Sensors and Photocatalysis for Antimicrobial Resistance Elimination' (AMSPARE), seeks to address this through the delivery of 4 key work packages, focusing on chemical effluent treatment plants (CETPs) as a hub for both antibiotic and industrial pollutants that are dispersed into riverine systems:

WP1: The mapping and statistical analysis of metagenomic and geochemical data. In addition, we look at the potential of utilizing microbial protists as models to explore the impact of the surrounding microbiome, and subsequent ecosystem on a multitrophic scale.

WP2: Using novel, optical and electrochemical sensing systems deployed in the CETP system to determine levels of key antimicrobials to provide an effective monitoring system for environmental release of these compounds.

WP3: Develop a photocatalytic process that can remove antibiotic residues and kill AMR bacteria already in the effluent, thus minimizing the risk of AMR in the water ways.

WP4: The consolidation of industry and government relationships to create and develop effective strategies to regulate antibiotic waste in the environment.

Within this presentation we summarize our results to date. We highlight discrepancies between molecular metagenomics and culturing results. As well as demonstrating preliminary data that suggests that predatory protist species, such as Acanthamoeba, might act as a vector, for AMR bacteria. We also highlight key antibiotics that are influenced by seasonal changes. This includes measuring the accuracy of detection with optical fibre sensors and antibiotics such as fluoroquinolone, ciprofloxacin and enrofloxacin, both under laboratory control conditions and with different environmental samples, e.g., lake and creek waters, urine and blood. Finally, we will discuss the importance of stakeholder and end-user engagement to improve buy-in and cross-sector collaboration.

S1-OP02

# Uncovering associations between anthropogenic pollution and antimicrobial resistance in the environment

**Erin Corbett**[1], Kiri Rodgers[1], Ronnie Mooney[1], Andrew Hursthouse[2], Soumyo Mukherji[3], Suparna Mukherji[4], Fiona Henriquez[1]

*[1]School of Health & Life Sciences, University of the West of Scotland, Hamilton, United Kingdom, [2]School of Computing, Engineering and Physical Sciences, University of the West of Scotland, Paisley, [3]Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay, Mumbai, India, [4]Department of Environmental Science and Engineering, Indian Institute of Technology Bombay, Mumbai, India*

Antimicrobial resistance (AMR) is a growing and significant threat to human health. Anthropogenic pollution is known to contribute to the spread of AMR in the environment through the co-selection of AMR genes alongside resistance genes to stressors such as potentially toxic elements (PTEs). In order to prevent and control environmental AMR, its mechanisms of spread and its relationship with contaminants must be better understood.

In this ongoing study, sediments were analyzed from up and downstream of a wastewater treatment plant in Mumbai, India, with the aim of identifying links between anthropogenic pollution and AMR. Chemical analysis included the measurement of physicochemical parameters (pH, conductivity etc.) as well as analysis of PTEs and anions through ICP-OES/ICP-MS and ion chromatography respectively). Microbial analysis was also carried out, focusing on the protist Acanthamoeba and exploring the role of free-living amoebae as vectors for AMR. Antibiotic susceptibility testing and metagenomic analysis were carried out on environmental samples (extracellular) and samples from within Acanthamoeba (intracellular).

Initial susceptibility tests found bacteria resistant to multiple common antibiotics (including ampicillin, vancomycin, and chloramphenicol) in both extracellular and intracellular samples. A greater proportion of intracellular bacteria exhibited resistance to tetracycline and erythromycin compared to extracellular bacteria from the same samples, suggesting that transfer of AMR may be occurring within the amoeba. The monitoring of Acanthamoeba and other predatory protists may therefore be an important aspect of tracking and controlling AMR.

Statistical analysis of chemical and microbial data then enables the identification of correlating factors associated with AMR and anthropogenic pollution.

**Funding Source**: NERC NE/T012986/1

S1-OP03

# Exposure to widespread environmental pollutants on the post-vaccination antibody potency or immunoglobulin levels of children

Xia Huo[1], Xijin Xu[2]
[1]*Jinan University, Guangzhou, China,* [2]*Shantou University Medical College, Shantou, China*

Evidence has accumulated that exposure to environmental pollutants has detrimental effects on the environment and on human health. Studies have found that exposure to environmental pollutants is associated with impaired immune function in children, but a few studies have focused on the relationship between environmental pollutant exposure and vaccine antibody potency or immunoglobulin (Ig) levels in children.
We summarize the effects of exposure to environmental pollutants including organic pollutants (OPs), heavy metals, and air pollutants on the childhood immune function and analyze the possible mechanisms underlying exposure-related alterations of antibody titers or Ig levels against different vaccines.
These studies investigated the associations of exposure to polychlorinated biphenyls (PCBs), perfluorinated compounds (PFCs), other OPs, heavy metals (Pb, Cd, As, Hg) and PM2.5 with the serum-specific antibody concentrations or Ig levels against different vaccines, such as anti-Hib, tetanus, diphtheria toxoid, IgA, IgE, etc. These studies suggest that exposure to these pollutants is generally associated with decreased potency of antibodies produced from childhood immunizations and overall deficiency in vaccines' provided protection. Pollutants exposure is associated with vaccination failure and decreased antibody titers, and increased risk of immune-related diseases in children by altering specific immunoglobulin levels. Age, sex, nutritional status, and co-exposure may influence the effects of pollutants on immune function in children. Epidemiological evidence suggests that exposure-induced changes to humoral immune-related tissue/cells/molecules response to vaccines may play predominant roles in the inverse associations between antibody responsiveness to vaccines and environmental pollutants. Results also help us to conduct better immunization policies for children under environmental pollutant burdens.

**Keywords**: environment pollutants, immune systems, vaccination, antibody, immune-related diseases, child health

S1-OP04

# Per- and polyfluorinated substances in Greece: Potential sources and potential human-health effects on the population

Georgia Soubasakou, Olga Cavoura
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**Introduction**: Per- and polyfluorinated substances (PFAS) are an emerging category of global contaminants that can have detrimental interactions with biological systems and adversely affect human health. With limited studies monitoring environmental levels, research is needed to assess the occurrence of specific PFAS, levels of exposure, and potential health effects.

**Methods**: The aim of this study was to review the data on PFAS in Greece. The identity and concentration range of PFAS-detected, methods of analysis including sampling techniques, extraction, instrumentation, and limits of detection were aggregated and evaluated for all studies between 2015 and 2022. Based on the matrix, the location, and surrounding environments, potential sources of release were identified, and potential health effects of dominant PFAS were reviewed.

**Results**: Studies covered indoor workspace dust, ground, surface and wastewater, and landfill leachate. Perfluorooctanoic acid (PFOA) was the dominant form in office dust, with a maximum concentration of 653 ng $g^{-1}$ detected in air condition filters (Besis et al 2019). Potential sources of PFOA were identified as carpet fibers. Similarly, PFOA was the dominant form in water samples: In Ozeros Lake the maximum concentration detected was 0.0219 μg $L^{-1}$. Agrinio wastewater treatment plant was identified as a potential source. In wastewater effluent the maximum PFOA concentration detected was 394 ng $L^{-1}$. (Koronaiou et al 2022). In landfill leachate, perfluorohexanoic acid (PFHxA) was dominant with a maximum concentration of 4284.8 ng $L^{-1}$(Koronaiou et al 2022). Specific PFAS have been associated with negative effects on thyroid and liver function. Serum PFOA levels were associated with elevated triglyceride levels and breast, prostate, pancreas, kidney, and liver cancer (ATSDR 2021).

**Conclusion**: The PFAS primarily identified in studies from Greece was PFOA. Due to severe potential human health effects, further investigation is necessary to map the potential for human exposure.

S1-OP05

# SARS-CoV-2 wastewater surveillance in Athens, Greece

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Wastewater-based Epidemiology (WBE) is a non-invasive and cost-effective chemical tool. Throughout the SARS-CoV-2 pandemic, the role of WBE is constantly enhanced and gains popularity as an early warning tool that offers new information on COVID-19 prevalence. Since the beginning of the pandemic, several scientists throughout the world have been monitoring the virus load in samples from the influents of Wastewater Treatment Plants (WWTPs). Detecting SARS-CoV-2 in wastewater remains difficult, even nowadays, when the virus has become endemic. The purpose of this research is to provide the case of SARS-CoV-2 monitoring in wastewater from the Attica region of Greece, as well as the methodology used and quality assurance approaches. Since August 2020, when surveillance began, two distinct methods have been deployed. Both approaches utilized polyethylene glycol (PEG) precipitation and a semi-automatic process based on membrane preconcentration, with Real Time-PCR as the detection technique. The method's challenges that were investigated were inhibitors, day-to-day sample variance, and viral load differences between distinct SARS-CoV-2 variants. Duplication of samples and PCR measurements was used as an internal quality control tool for measurement and dilution as an inhibitor assessment tool. Finally, using the above data, a top-down approach to uncertainty estimation using Robust ANOVA was applied, allowing us to suggest a suitable fitness for purpose criterion.

S1-OP06

# Scottish seaweed: Use and abuse from the Stone Age to the current day

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Seaweed was used in Neolithic sites in Scotland as animal feed, and cremation fuel. Through the 18th and 19th centuries, seaweed was incinerated to produce ashes with a high carbonate of soda content, used commercially in glass and soap manufacture. Later, seaweed ash was a commercial source of iodine for chemistry and medicine.

Through incineration, about 20 tons of seaweed (kelp) produced one ton of ash (also known as kelp), with up to 50% of the iodine content lost to the atmosphere. High air concentrations over large distances from the incineration site increased iodine intake by humans and animals.

Unfortunately, the kelping industry was closely associated with the dark underbelly of capitalism: boom/bust, resurgence/misery, profit/exploitation, contributing directly to the infamous Highland Clearances, where thousands of people were forcibly removed from Scotland. The Scottish industry died in the early 20th century from competition by cheaper Chilean iodine.

In the 21st century, the Scottish seaweed industry is again active, contributing a variety of products, including human foods, animal feed, fertilizer, hydrocolloids, biofuels, and bio actives used in the nutrition, pharmaceutical and cosmetic industries.

Concerns, however, have risen about the direct human consumption of seaweed or the use of kelp supplements: toxic effects are recorded. Because of their highly variable but concentrated iodine content, seaweed and kelp-based supplements should be avoided. The UK Vegan Society (https://www.vegansociety.com/) and the British Dietetic Association (https://www.bda.uk.com/resource/iodine.html) recommend supplements based on potassium iodide/iodate as suitable for use in pregnancy or by dietary restrictors.

It is to be hoped that the current Scottish seaweed industry is not party again to unbalanced discussions and decisions which can have adverse and lasting effects on the lives of ordinary people but, instead, is able to support the wise use of kelp to enrich the public through more than economic profit.

S1-OP07

# Preliminary results of potentially toxic elements content and biological accumulation in two species of sea cucumbers

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**Introduction**

Potentially toxic elements (PTEs) are a major pollutant and can accumulate in the food chain, degrading the ecosystem structure. However, in specific amounts, they play a significant role in the health of organisms, affecting various biological processes such as growth, reproduction, and activity (migration, development) (Ahmed et al., 2016). Additionally, PTEs tend to precipitate and accumulate in bottom sediments when in aquatic environment, hence affecting nonselective feeders such as sea cucumbers (Fretes et al., 2020). Sea cucumbers contribute to recycling and bioturbation of sediments, enabling them to modify the benthic zone's ecosystem, therefore are considered to be substantial bio-indicators in aquatic ecosystems (Ahmed et al., 2017). This is the first time that this type of study has been conducted in Pagasitikos gulf.

**Methods**

Two species of sea cucumbers (Holothuria poli, Holothuria tubulosa) and surficial sediment samples were collected from Agistri area (39°18'02.6"N - 22°56'50.8"E), located in Pagasitikos gulf. All samples were collected by scuba diving, with depths ranging from 5 to 15 m. The edible muscle tissue and intestine were transferred to the laboratory, where samples were pretreated as proposed by Culha et al (2016). The determination of As, Cd, Cr, Cu, Mn, Pb, Zn content was carried out using Graphite Furnace and Flame AAS. Biota Sediment Accumulation Factor is an indicator used to describe bioaccumulation of metals into tissues of ecological receptors. BSAF = Ct/Csed where Ct: PTE content in tissue and Csed: PTE content in sediment. Statistical analysis was employed to detect significant differences between the two species.

**Results**

Statistical analysis of data showed significant differences between the two species, for the elements As, Cd, Cr, Cu, Pb, Zn in muscle tissue and As, Cu in intestine content. Significant differences were reported for all elements regarding sediment samples, intestine content and muscle tissue as expected. The average BSAF values for H. poli were, As: 0.17, Cd: 0.14, Cr: 0.01, Cu: 0.02, Mn: 0.06, Pb: 0.04, Zn: 0.1, while for H. tubulosa were: As: 0.23, Cd: 0.2, Cr: 0.02, Cu: 0.004, Mn: 0.16, Pb: 0.13, Zn: 0.16.

**Conclusion**

According to BSAF, the elements with the highest accumulation were As and Mn. Although there is an obvious accumulation difference in sea cucumbers tissues between the two species, metal contamination was not found to be a major issue in general. The differences observed for the elements in muscle tissue and intestine content for both species may be attributed to the effects of different factors, such as vital importance of elements, concentration, exposure time, metabolic rate, feeding habits, whereas factors affecting the presence of trace and heavy elements in sediments are the coexistence of other elements or compounds in the environment and physico-chemical characteristics of the medium.

**Acknowledgement**

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S1-OP08a

# Organochlorine pesticide ban facilitated reproductive recovery of Chinese striped hamsters

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**Introduction**: Organochlorine pesticides (OCPs) have been used worldwide on an enormous scale over the last century but are banned globally due to environmental persistence and ecotoxicity in recent decades. A number of studies have still reported high detection frequency and contaminated levels of these pesticides in various environments. However, long-term effects of OCP-ban for agricultural use in China since 1983 on the reproductive health of small terrestrial mammals have never been evaluated in the field.

**Methods**: We examined the residue dynamics of OCPs and the reproductive performance of Chinese Striped Hamsters (Cricetulus barabensis) at the population level in North China Plain during 1983-2010. The associations between internal exposure to OCPs and several reproductive performance indexes after adjusting for environmental factors were determined using the generalized linear model.

**Results**: It showed that the internal exposure levels of OCPs in hamsters drastically decreased from 2900 ± 740 ng/g to 25.2 ± 6.88 ng/g with an average half-life of 5.08 years, coinciding with the observed reproductive recovery of hamsters. The population-based reproductive performance (indexes) of hamsters was significantly and negatively associated with OCP exposure levels after adjusting the contributions from climate (temperature and precipitation) and population density factors, indicating that the ban of OCPs has facilitated the reproductive recovery of hamsters by up to 81% contribution.

**Conclusion:** Our findings suggest that the OCP ban is effective to restore the reproduction of small terrestrial mammals. Integration of population biology and environmental science is essential to assess the impacts of persistent organic pollutants on ecological safety and biodiversity loss under accelerated global change.

S1-OP08b

# Potentially toxic elements profile of some selected medicinal plants growing naturally in the vicinity of abandoned tin mines on the Jos Plateau and their human health risk assessment

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Potentially toxic elements (PTEs) contamination is another potential safety concern for medicinal plants used to treat diseases, particularly in developing countries, including Nigeria. This study was designed to determine the level of PTEs in soil and selected medicinal plants obtained from abandoned tin mines and assess the potential health risk associated with medicinal plant consumption using the data recommended by the United States Environmental Protection Agency. Soil and selected medicinal plant samples collected from abandoned mines and background areas were analyzed for selected PTEs (Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn)) using inductively coupled plasma mass spectrometry (ICP-MS) after sample digestion. The transfer potential of PTEs from soil to medicinal plants was assessed using the bioaccumulation factor. The results showed that the levels of heavy metals determined in the abandoned mine soil were several folds above their corresponding levels in the background area soil. The medicinal plants determined vary in their ability to take up and accumulate heavy metals in their tissue parts. The hazard quotient (HQ) values for most of the heavy metals were greater than 1, indicating potential health risks for both adults and children. It can be concluded, based on the results and risk assessment provided by this study, that human exposure to medicinal plants from abandoned mines constituted a potential health risk for consumers.

S1-OP09

# Effects of kaolinite on the transport of ferrihydrite colloids in underground environment

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Ferrihydrite colloids occur ubiquitously in the natural environments and is well-known to play a vital role in the fate and mobility of contaminants. Most research of colloids centered on the transport of colloids in varying physicochemical perturbations conditions and believed that the colloids migration was hindered when agglomeration happened. However, colloids transport is also affected by the properties of the solid medium surfaces. Clay mineral is a significant component of the porous media in aquifers, the impact of minerals on colloids transport is largely overlooked. Taking the kaolinite as an example, the clay mineral how and to what extent modulated the transport of ferrihydrite colloids was investigated via column experiments, batch experiments, isothermal titration calorimetry (ITC), X-ray absorption fine structure (XAFS), and density functional theory (DFT) calculations. Our results reveal that the kaolinite coated sand column has the stronger inhibition effect than the sand column on the mobility of ferrihydrite colloids. The estimated maximum travel distance of ferrihydrite colloids under the absence of kaolinite reaches 9.8-fold larger than that in the presence of kaolinite. The reduced travel distance was primarily attributed to the adsorption of ferrihydrite colloids by kaolinite, with the maximum adsorption capacity was 19.8 mg g-1. The ferrihydrite colloids cannot remobilized from the column under the presence of kaolinite by changing pH value and ionic strength. This may be due to the inner-sphere complexation formed between the ferrihydrite colloids and kaolinite, and the assumption was confirmed by the results of isothermal titration calorimetry (ITC). The results of XAFS and DFT calculations revealed that ferrihydrite colloids coordinated to the surfaces of kaolinite via the formation of monodentate inner sphere complexes and exhibited high thermodynamic stability. These new findings will help to understand the transport behavior and mechanism of ferrihydrite colloids in underground environments and provide a scientific basis for prediction of the contaminant's behavior in the environments.

**Keywords**: ferrihydrite colloids transport, kaolinite, ITC, XAFS, DFT

S1-OP10

# Respiratory bioaccessibility of metal(loids) in contaminated soil (<10 μm) from highly urbanized and industrial environments

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Soil in urban areas is one of the main sinks of pollutants. It is well known that there is a strong link between metal(loid) bioaccessibility via inhalation and human health. Particles with size <100 μm can enter human respiratory system through inhalation; however, the critical size fraction is <10 μm since they approach to the tracheobronchial region. In the current study we examine the bioaccessibility of metal(loids) in <10 μm particle size of ten soil samples from Athens which is a highly urbanized area, and ten soil samples from Volos city which is surrounded by industrial units. For the separation of the <10 μm soil fraction we used wet sieving and sedimentation according to Stokes' Law. We used the EPA 3050B method to access the pseudototal metal(loid) content, while the respiratory bioaccessible fraction was extracted using the Artificial Lysosomal Fluid (ALF). We applied XRD analysis technique to determine the principal mineralogical constituents and environmental magnetic measurements to investigate the magnetic signature of representative samples. Lead isotopic compositions of the samples were determined to identify possible sources of total and bioaccessible Pb in the <10 μm soil fraction. We compared the rates of the lung bioaccessibility in <10 μm particle size with previous studies at these areas regarding the < 100 μm fraction. In addition, the influence of basic soil characteristics (pH, Total Organic Carbon) on metal(loid) bioaccessibility was examined. Finally, the potential human health risks were assessed by the models developed by the United States Environmental Protection Agency aiming to estimate the non-carcinogenic and carcinogenic risks. Urban geochemistry has known great development worldwide but in Greece research is limited. So, this study aims to enrich the scientific knowledge about inhalable PTEs health impact and to help for further research in order to improve the quality of life in urban areas.

S2-OP11

# Radon in tap water: Is it safe to assess the health risk for people only by means of reference thresholds? A case study from Campania region (Italy)

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Groundwaters of Campania region in southern Italy, represent a valuable resource for local population due to their use as drinking water and for irrigation purposes. Their quality is strongly conditioned by the composition of the host rocks, which may vary from volcanic to sedimentary lithologies. As they are used to supply the regional aqueduct system, these waters undergo continuous quality checks to preserve public health.
Such as air and soil, natural waters can contain naturally occurring radionuclides (NORs) and their decay products. Radon-222 (Rn-222) is a daughter product of U-238; it is a natural radioactive noble gas which is normally present in drinking water. Ionizing radiation proceeding from Rn-222 contained in tap waters provide, through ingestion and inhalation, the largest human internal exposure to natural radiations.
In Italy, the Legislative Decree No 28/2016 establishes a as a guideline a reference threshold value of 100 Bq/l for tap waters; this threshold is applied to prevent the use of tap waters use for drinking purposes and other related uses. Scientific literature showed that the application of a risk assessment-based approach can lead to more reliable results in terms of health and safety than the mere application of general reference values. The World Health Organization (WHO) (2004) does not consider the “guideline approach” as viable solution for risk assessment and suggests to quantify health risk for Rn-222 by determining the Indicative Dose (ID). The ID represents, in facts, the dose of radiations assumed by an individual through ingestion and/or inhalation, as a consequence of an environmental exposure.
In Campania region, Rn-222 measurements in drinking water were performed at different sections of the public aqueduct system including springs, wells, water tanks and public fountains.
Results showed that in Campania deep groundwater exchanges between natural reservoirs occur bringing unexpected enrichments of Rn-222 in springs and wells drawing water even from non-volcanic aquifers. Furthermore, the concentration of Rn-222 in the aqueduct system changes as the distance from the water collection point increases and depends on several factors related with the characteristics of the sections where measurement were done.

Since the application of the national guideline (100 Bq/l) resulted in a condition of potability for all the analyzed tap water samples, with the aim of evaluating the effectiveness of the risk assessment-based approach to improve the degree of protection of human health a stochastic risk assessment was performed for homogeneous areas supplied by specific hydrogeological units of the region.
In contrast to the results obtained using the guideline approach, the probability for local population to be exposed to an unacceptable risk for Rn-222 due to water drinking (or showering) resulted considerably high specially for those areas totally or partially supplied by waters proceeding from the regional volcanic domains.

As a consequence, this study can be seen as a proof of concept in relation to the WHO suggestion to avoid the use of guidelines in favor of ID determination to assess the risk.

**References**

WHO (World Health Organization), 2004. Guidelines for Drinking-water quality.

S2-OP12

# Destruction and removal of a problematic dye in wastewater with heterojunction photocatalysts

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**Introduction:** In this study, a series of ZnO based heterojunctions with varying loadings of WO3 and BiOI have been synthesized for the photodestruction of methyl orange (MO) dye, a problematic textile effluent, in aqueous solution.

**Methods:** Observations from scanning electron microscopy, energy-dispersive x-ray spectroscopy, x-ray diffraction, optical studies and nitrogen adsorption-desorption isotherms showed agglomerated images with high porosity and sponge-like morphology. There is also evidence of crystalline patterns with no impurity peaks, slight red shift in the absorbance of the heterostructure, presence of only the reference elements and mostly Type IV isotherm adsorption behaviour.

**Results:** The composites ZnO-[10%]BiOI and ZnO-[10%]WO3 heterojunctions were identified as the best performing photocatalysts in this study as MO was completely destroyed in 150 and 120 minutes, respectively. It confirmed 10% wt as the optimal doping concentration for the best photo-activity. The influence of different process parameters indicates that at an increased photocatalyst dose of 40 mg, both heterojunctions rapidly destroyed MO, while a decline was observed at 40 ppm MO concentration. The photodegradation of MO was more successful in high acidic (pH 2) media when compared to high alkaline media (pH 11) for the ZnO-[10%]BiOI heterostructure, while a decline was observed for high acidic and alkaline pH when ZnO-[10%]WO3 was applied. The kinetic fits of the photodestruction study show that all the photodegradation reactions could be fitted to a pseudo first order kinetic model.

**Conclusion**: The results obtained from this study indicate that ZnO-[10%]BiOI heterojunction photocatalyst can be very useful for the treatment of dye wastewater.

S2-OP13

# Naturally occurring geochemical enrichment of thallium, cadmium, and fluorine and related health risks in southwestern China: A geo-environmental perspective

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The elevated concentrations of thallium (Tl), cadmium (Cd), and fluorine (F) in the environment and their potential health risks in southwestern China have been widely recognized. In our recent study, we conducted analyses of the enrichment, migration, and health risks of Tl, Cd, and F in high geological background areas of southwestern China. Our findings reveal that endemic Tl poisoning occurred due to Tl contamination in local drinking water and vegetables surrounding the Tl-rich sulfide mineralized areas. The geogenic enrichment of Tl in local soils was caused by the weathering process of Tl-rich rocks/sulfide minerals, as well as local anthropogenic activities such as mining and agriculture. The significant accumulation of Tl in crops poses a threat to the health of the local public. Similarly, Cd is typically enriched in black shale, with geogenic enrichment in soils caused by the weathering process and local long-term mining and combustion of low-quality coal. Cd primarily appears in the water-soluble and exchangeable fractions, exhibiting high mobility and bioavailability. Our observations indicate that Cd is present in high levels in local crops and urine samples of local residents, and the surface enrichment of geogenic Cd poses a threat to local food quality and human health. F is also enriched in local coals (anthracite, coal gangue, blended coal clay, etc.) and soils, and the domestic combustion of coal balls, composed of coal mixed with soil, leads to elevated F released into indoor air, causing health risks such as endemic skeletal fluorosis and dental fluorosis among local residents. Overall, our study provides valuable insights into the enrichment patterns and potential health risks of Tl, Cd, and F in high geochemical background areas from a geo-environmental perspective.

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S2-OP14

# Thriving in toxic: morphological, geochemical and spectroscopic evidence for As-Pb-Sb—related microbial activity in the hydrothermal sulfide diffusers of the Kolumbo active underwater arc-volcano, Aegean sea

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Modern seafloor hydrothermal vents create an environment of extreme physicochemical conditions such as high acidity, discharge of high-temperature climate relevant magmatic gasses and potentially toxic metal(loids). This extreme environment is home to highly complex microbial communities and to antibiotic and multidrug resistant bacteria that can influence the cycling of toxic metal(loids), such as As, Sb, Pb, Tl and mineral precipitation. Furthermore, the investigation of these extremophiles can provide insight to the evolution of primitive life in the ancient oceans (Hu et al., 2020, Bravakos et al., 2021). Arsenic, although an important pollutant for marine life, is regarded as a proxy for ancient microbial activity, nonetheless, microbially induced precipitation of As-sulfides is yet poorly understood (Hu et al., 2020). In this study we provide morphological, spectroscopic and geochemical evidence for microbial activity associated with orpiment ($As_2S_3$)-like filamentous structures from the active sulfide diffusers, Kolumbo submarine Arc-volcano.

The morphology of filament structures was examined through polarized reflected and transmitted light microscopy. Detailed geochemical analyses on the filaments were performed by FEG-SEM, and LA-ICP-MS. In addition, Raman spectroscopy was employed, in order to detect and evaluate specific Raman peaks indicative of carbonaceous material in the filaments.

The orpiment-like structures are found in the outermost parts of the diffusers as a mycelium-like network of branching fungi-like filaments mineralized by As-sulfides and exhibit, concentric internal structure, twisting, and putative septa. LA-ICP-MS analyses of the filaments show an enrichment in precious (Au, Ag) and toxic (Tl, Sb, Pb) metal(loids). Examination by Raman spectroscopy indicated the presence of peaks within the wavelength bands between 1000-1800 cm-1, and 2700-3000 cm-1. Such spectroscopic features have been interpreted as carbonaceous matter (Dekov et. al., 2022).

The morphological features of the studied filaments, combined with their distinct spectroscopic characteristics and their geochemical composition suggest that they are fossils of mineralized fungi/microbes that metabolized As (Hu et. al., 2020, Dekov et al., 2021). The precise metabolic mechanism involved is yet to be deciphered. The identification of organic bonds in these structures demonstrate microbial activity and suggests bio-sequestration of As and S. Possibly fungal activity was present during the precipitation of orpiment and presumably related to the precipitation mechanisms of As-mineral deposition. This is an ongoing investigation, and we plan to use FIB-SEM and HAADF-STEM (e.g., Hu et al., 2020) technology to further study and prove the role of microorganisms (i.e., fungi, bacteria etc.) in As-Pb-Sb-biomineralization and its relation to the potential release of toxic metal(loids) in the water column.

S2-OP15

# Environmental risk assessment of a hazardous waste landfill surroundings

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**Introduction**
Comprehensive studies were carried out in the surroundings of a hazardous landfill to gain an overview of its current environmental status. The studies included the demonstration of different risk assessment methods that were applied to estimate the potential risks posed by the hazardous waste landfill to people and the nearby environment.

**Methods**
The fieldwork and sampling (surface waters, groundwater, stream sediments and soil) obtained an overview of the environmental status of the landfill surroundings and collected the information for the environmental risk assessment. Together with basic chemical parameters and physical characteristics, a wide range of contaminants were analyzed and ecotoxicity tested from the samples.
Conceptual models for the study area were established. The risk was assessed by comparing the results with the national maximum permissible concentrations (MPC values) and through calculations of risk quotients, an EPISuite™ model, the bio-met bioavailability tool and modelling with the Risk-Based Corrective Action (RBCA) Tool Kit.

**Results**
Transport via stream waters was found to be the most important transport route for contaminants from the landfill to the surrounding environment. The highest chemical concentrations and risk quotients in water, soil and sediment were detected close to the landfill.
In surface water, many water quality indicators exceeded the MPC values over the whole study area. The sum of risk quotients for metals was highest close to the landfill. Some halogenated volatile organic compounds, phenols, PCBs, anionic surfactants, formaldehyde, oil products and naphthalene exceeded the MPC values for organic compounds. Three of ten tested water samples were classified as highly toxic to Paramecium caudatum. The sum of risk quotients for different contaminants indicates that the contaminants pose a risk in sediments throughout the study area. Many metals and phenols exceeded the MPC values in soil.
The bioavailable concentrations calculated using the bio-met model were considerably lower than the measured concentrations. According to the results of the EPISuite™ model, dioxins, PCBs, some of the PAHs and pesticides are highly lipophilic and sparingly soluble in water, thus, soil and sediment are the main endpoints for them. Based on the results yielded by the RBCA tool kt, the highest risks are related to exposure to the contaminants through outdoor air, groundwater, or soil exposure pathways. Carcinogenic risk level for groundwater exposure pathway was exceeded in the whole study area.

**Conclusions**
Despite the findings in the study area, the landfill surroundings do not appear to cause a clear contamination effect under the present environmental conditions on the river that is used for water intake (located ~15km from the landfill). However, as long as the landfill has not been properly remediated, in case of accidental leakages or overflows in the landfill, the migration of pollutants to the surroundings and finally to the water intake may take place.
Sources of uncertainty in the study are remarkable, thus, the results of the risk assessment should be considered indicative.

The risk assessment report is available at: https://tupa.gtk.fi/raportti/arkisto/19_2022.pdf. The project was co-funded by the European Union (project ID KS1203).

S2-OP16

# Presence of asbestos in building materials and soils in urban areas

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**Introduction:** Wildfires in urban areas can negatively affect the quality of soils as well as cause the destruction of building materials that in many occasions contain asbestos fibres which is harmful to humans. The present study has been carried out to determine the presence of asbestos in the postfire urban areas of Attica, Greece that were affected by wildfires in 2018.

**Methods:** The samples tested in this work were collected from prespecified spots of the burned areas. The samples included different types of materials such as bricks, wall coatings, insulation plates etc. Soil samples near the buildings were also collected. The identification of asbestos and its different types was performed with the use of polarized light microscopy (PLM) according to P401 provided by BOHS (HSG 2021). The samples were smashed, cleaned and observed firstly under stereomicroscope in order to be examined for the presence of fibrous particles and then these fibrous particles were extracted, mounted into an RI liquid and observed under PLM. Scanning electron microscopy was also used to validate the presence of these 2 types of asbestos.

**Results:** The identification of asbestos was based on the optical properties of the fibrous particles. In this work, 2 different types of asbestos were determined, chrysotile and crocidolite. In some cases, asbestos was also detected in the aforementioned soil samples indicating dispersion of the fibres in an area around the burned spots.

**Conclusions:** The presence of asbestos that was identified in this preliminary study could raise concerns to humans in the urban areas. As a result, further investigations should be made to examine the issue more thoroughly.

S2-OP17

# Analysis of the release of synthetic micro and nanoparticles and chemical contaminants from disposable plastic face masks

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With the increase on the manufacturing and use of disposable plastic face masks (DPFMs) due to the Covid-19 pandemic, the inappropriate and unregulated disposal of these items is a concerning cause of the intensification of plastic as an environmental problem nowadays. The objective of this study is to analyze and ascertain the potential risks for the environment and for human health that this new source of plastic pollution poses. It has been demonstrated that DPFMs degrade and release synthetic fibres and particles in the micro and nanoscale, but the fate of these pollutants is still unknown.
In order to simulate the wearing and leaching processes that DPFMs undergo under environmental conditions after disposal, they were treated inside an environmental chamber to mimic UV degradation and were also submerged in deionized water to test their potential capacities of releasing pollutants in water.

The subsequent leachates and deteriorated items were analyzed utilizing different technologies, like Field-flow fractionation (FFF) coupled to UV/VIS and multi angle light scattering (MALS) for nanofraction separation, pyrolysis gas chromatography-mass spectrometry (Py-GC-MS) for polymer characterization, inductively coupled plasma mass spectrometry (ICP-MS) for metal identification and light microscopy, scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) for visualization of fibers and particles.

Polypropylene was confirmed as the primary material used on the manufacturing of the face masks by Py-GC-MS analysis. All DPFMs emitted fibres and crystalline fragments (believed to be of siliceous composition). The use of FFF-UV/VIS-MALS and SEM-EDX demonstrated that the size of the particles is in the micro (<1 mm) and nano (submicron particle size 0.1-1 µm) range. Associated with these particles, there was often presence of heavy metals associated (such as Pb, Cd, Sb and Cu) that are common chemical additives added during plastic manufacture.

S2-OP18

# Evaluation of microplastic pollution on beaches of Leros, Greece

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Defined as particles of < 5 mm in size, microplastics (MP) in the marine environment are considered a significant environmental threat that have been linked with detrimental effects on terrestrial and aquatic organisms and have raised concerns for public health. This study assessed MP pollution on Alinda and Gourna Beaches, in Leros, a small island in Dodecanese in Southeast Aegean Sea. On the eastern coast, Alinda is situated in the same gulf as the island's main port and is a popular tourist location during the summer months. Gourna Beach is located on the western coast and is also a popular tourist spot. Samples were collected both from the high tide line and from random sites along the beaches and sieved at 5mm. After drying, density floatation with saturated NaCl was used to separate PM, and organic matter was decomposed with peroxide digestion. Samples were filtered to retain MP, and visual and stereoscopic inspection were performed to categorize MP according to shape, size and colour. Pellets, foams, microfibers, films and fragments were identified, with fragment MP most identified most frequently. Concentrations of MP were in the range 5 to 183,3 items per kg of dry weight sediment at different sites on Alinda Beach and for Gourna Beach MP concentrations ranged from 96,7 to 230 items per kg of dry weight sediment. Average MP concentration was 106,7 and 581,1 items per kg of dry weight sediment for Alinda and Gourna Beach respectively. Despite the remote location of Leros island, the high concentration and variety of MP determined highlights the necessity for further research on sources of MP pollution, seasonal variation of MP concentration, and human exposure to these pollutants.

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S3-OP19

# Potentially toxic elements in dust of Cyprus homes: Magnetic susceptibility and human health risk assessment

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The use of household dust as a sampling medium to measure human exposure to anthropogenic metal(loids), through inhalation, ingestion, or skin contact absorption, is gaining popularity globally (Kelepertzis et al., 2019). In addition, anthropogenic magnetic particles which are carriers of various pollutants such as PTEs are responsible for the higher magnetic enrichment in dust (Jordanova et al., 2014) and they could be used to identify hot spots of iron and associated heavy metal(oid)s.
The objectives of the present study are to provide insights of the human health risk assessment for seven Potential Toxic Elements (PTEs) (As, Cr, Cu, Mn, Ni, Pb, Zn) in Cyprus dust and the comparison of the risk to those reported worldwide (Isley et al., 2022). Furthermore, we report on magnetic susceptibility of the collected samples and its correlation with PTEs. The studied samples were collected from homes located within the urban areas of Nicosia (Lefkosia) and Limassol (Lemesos), and from Mitsero village which lies near an abandoned open pit Cu-mine.
Thirty-eight vacuum dust samples were collected and prepared for analyses following the protocol of the Home Biome –DustSafe citizen-science study (Isley et al., 2021) from May to September 2021. The samples were analysed for trace elements using energy-dispersive X-ray fluorescence spectrometry (EDXRF). Magnetic susceptibility was determined following the process of Kelepertzis et al., (2019). Magnetic susceptibility measurements showed high correlation with As, Pb, and Zn contents in Cyprus household dust and with house age. Furthermore, the human carcinogenic risk for children under of 2 years old in Cyprus was recorded as the highest for the case of Pb, Cr, and Ni compared to the global DustSafe residential dust database. Overall, the present study is a further contribution to the open global DustSafe database and expands our knowledge about human health risk assessment and how magnetometry contributes to the detection of human inputs of PTEs in household dust.

**Acknowledgements**
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S3-OP20

# Baseline characterization of Pb-Zn-Cu-Cd-As mine soils using pXRF for phyto-stabilisation trials using Phalaris arundinacea.

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The former Queensbury tailings pond at Wanlockhead has been identified by the Scottish Environmental Protection Agency (SEPA) as a major source of Pb, Zn, Cu & Cd entering Wanlock Water (a tributary of the River Nith) contributing to sediment loadings and its "less than good" status for water chemistry under the Water Framework Directive. Phytoremediation trials are being conducted as part of the CERESiS project (www.ceresis.eu) as a nature-based solution to reduce the erosion of mine tailings under flood events, sheet wash or infiltration. This involves planting a novel native energy crop species (Phalaris arundinacea) capable of physically stabilizing contaminated soils without significant uptake.

In 2022 a Niton XL3t980 pXRF was used to define the extent of potentially toxic elements as part of the site investigation and baseline survey The feasibility survey focused directly on the 10 x 10 m plant trial site where a regular grid of 25 surface samples (n=25) were taken using a hand trowel (0-10cm), with 5 gouge auger continuous samples (0-30cm) at the grid corners and centre. These were oven dried and sieved < 2mm in the laboratory before being analyzed remotely at BRGM. In the follow-up survey, random surface samples (n=32) were taken across the full extent of the former tailings area (0.75 ha), bagged and analyzed wet and un sieved in the field.

Results confirmed the elevated concentrations, extent and spatial variability of PTE concentrations in the phytostabilisation site soils, including with depth. Sieving samples increased concentrations of some PTE indicating preferential fine-grain contamination. In general, using the pXRF allowed for fast and effective mapping of contaminant distribution and could be used to guide the assessment of sites for energy crops on heterogeneous non-agricultural sites and the design of nature-based approaches to mitigate future impacts of metal mining legacy sites.

S3-OP21

# Trace metal content prediction along an AMD (Acid Mine Drainage)-contaminated stream draining a coal mine using VNIR–SWIR Spectroscopy

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**Introduction and Methods**: The current study investigated the use of VNIR–SWIR (visible/near infrared to short-wavelength infrared:~400 – 2500 nm) spectroscopy for predicting trace metals in overbank sediments collected in the study site. Here, we (i) derived spectral absorption feature parameters (SAFPs) from measured ground spectra for correlation with trace metal (Pb, Cd, As and Cu) contents in overbank sediments, (ii) built univariate regression models to predict trace metal concentrations using the SAFPs and (iii) evaluated the predictive capacities of the regression models.

**Results**: The derived SAFPs associated with goethite in overbank sediments were Depth433, Width433 and Asym433, and those associated with kaolinite in overbank sediments were Depth1366, Asym1366, Width1366, Depth2208, Asym2208 and Width2208. Lead and Cd in the overbank sediments showed the strongest correlations with the goethite-related SAFPs, whereas As and Cu showed strong correlations with goethite- and kaolinite-related SAFPs. The strongest calibration regression models were obtained for As (R2 = 0.71), Cd (R2 = 0.70) and Cu (R2 = 0.70) while a weaker model was obtained for Pb (R2 = 0.53). Based on RMSEPCV (root mean squared error of prediction of cross-validation), the most accurate predictions were obtained for Cd (RMSEPCV = 0.04), followed by As (RMSEPCV = 1.70), Cu (RMSEPCV = 2.50) and Pb (RMSEPCV = 4.90).

**Conclusions**: The results suggest that trace metals (even at ppb levels) can be predicted indirectly using the SAFPs associated with goethite and kaolinite. This is an important benefit of VNIR–SWIR spectroscopy considering the difficulty in analyzing 'trace' metal concentrations, on large scales, using conventional geochemical methods.

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S3-OP22

# Pyrite (FeS2) as an accessory mineral and its effect on the content of As, Fe and S in soils

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Pyrite ($FeS_2$) - a primary sulfide mineral, is very commonly found in talc deposits ($Mg_3[(OH)_2|Si_4O_{10}$) as an accessory mineral and as such generates a considerable environmental risk, especially for aquatic ecosystems. This risk is associated with strong acidification of water (pH<4) and the accompanying release of metals and metalloids. Thus, a particularly significant environmental aspect of exploiting deposits containing pyrite is to determine the texture and reactivity of co-located minerals which have the ability to buffer low pH and conduct an in-depth analysis of weathering zone location and the content of accessory elements.
Based on the study material collected: i) primary minerals (talc), ii) waste (with different degree of weathering) and iii) soils, we conducted an environmental risk assessment related to the presence of Fe, As and S compounds. For that purpose, we determined: the total concentration (XRF), pseudo-total concentration (aqua regia), water leaching (1:10 ratio) and fractions of the elements analyzed (four-step BCR extraction) in the study material.
In the primary material subject to exploitation (talc deposit), Fe and S compounds were found in the following amounts (data in wt.%): 4.46 and 0.45. The content of arsenic, on the other hand, was decidedly lower (2–3 mg/kg). Waste collected from spoiled tips contained markedly higher amounts of the elements analyzed: As up to 139 mg/kg, Fe up to 8.44 wt. % and S up to 0.45 wt. %. As for the soil material, the most abundant element was Fe (up to 10 wt. %), with S (up to 406 mg/kg) and As (do 63 mg/kg) found in slightly lower amounts as compared to waste. The amounts of As, Fe and S leached with water solutions were (data in % of the pseudo-total concentration): 4, 0.049 and 19, respectively. The following amounts of As, Fe and S were found in exchange positions and bound to carbonates in soils: 8, 0.01 and 10% of the total concentration, respectively. 8, 0.4 and 8% of the total concentration of these elements were bound to the oxide fraction and 10, 1.6 and as much as 56% of the total concentration were bound to the organic fraction. Nearly 74, 98 and 26% of the total concentration of the elements were found in the residue.
Based on the analyses conducted, it was found that the highest environmental risk, especially for the producer level, stemmed from the release of phytoavailable as from sand accumulated spoil tips (up to 35% of the total concentration) and S compounds (up to 37%). The risk is associated with the weathering (oxidation) of primary sulfate forms, which in the presence of atmospheric oxygen are unstable.

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S3-OP23

# Plutonium: A novel soil erosion tracer in Eastern Africa

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Soil erosion presents a significant risk to land degradation globally, with developing countries facing the greatest risk due to rapid expansion of agriculture, sometimes onto marginal land in response to rapid increases in population as well as the limited availability of land suitable for agriculture. In this study, the usability of plutonium (Pu) to determine soil redistribution rates within the Winam gulf catchment of western Kenya was investigated at sites with differing land use and clearance scale. Fallout Radionuclide inventories (unsupported 210Pb, 137Cs and 239+240Pu) were determined across seven suitable reference sites by gamma spectroscopy and ICP-MS/MS to test the applicability of Pu as a tracer of soil erosion. The lowest variability across the reference sites was found for 239+240Pu which can be attributed to increased sensitivity in detection by ICP-MS/MS compared to gamma spectroscopy. Subsequently 239+240Pu was used as a tracer at four study sites representing different land management approaches and history of land clearance of tropical rainforest. Plutonium showed interesting spatial characteristics for land management techniques highlighting the differences between top-down mitigation strategies and bottom-up (farmer led) mitigation strategies. In short, 239+240Pu presents a valuable tool for the determination of soil erosion rates in tropical Africa to increase understanding of land degradation. Therefore, providing reliable data to help decision making in the planning of appropriate mitigation strategies. This work demonstrates the potential for interdisciplinary benefits of research to be derived from novel analytical methodology to better inform land management.

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S3-OP24

# Innovative instrumentation for in situ monitoring of marine radiotracers*

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The seawater includes various natural radioisotopes, mainly 40K and the two decay chains of the long-lived 238U and 232Th. The latter decay chains are commonly used as tracers for geochemical processes in the marine environment (R.J. Pentreath, 1985). Characteristic radionuclides of human origin include 137Cs and 90Sr (H.D. Livingston & P.P. Povinec, 2000), which mainly originate from radioactive releases to the environment (e.g. Fukushima). Radioactivity data from the oceans are quite limited and mainly focused on coastal areas, derived either in situ or by analysis of sediments and water samples.
RAMONES is an EU H2020 FET Programme aiming to overcome current limitations in marine radiotracers monitoring by providing in situ, near real-time, extended, and continuous radioactivity monitoring in the aquatic environment. Validated dense radioactivity data collected will enable detailed geoenvironmental modelling and predict radioactivity related risks such as geohazards including earthquakes and underwater volcanic activities. To that extend RAMONES will develop a set of novel radiation instruments combining radiation sensors with robotic vehicles and AI assisted algorithms. Within a particularly interesting class of instruments called γ-sniffers the use of mobile gamma spectrometers aboard autonomous underwater gliders is proposed. Their role will be to survey extended areas of the seawater column and spot increased levels of radioactivity.
First results are derived from the response characterization of these spectrometers under experiments in laboratory conditions and detailed Monte Carlo simulations. The first field tests have also been performed to provide feedback under realistic conditions. In conclusion, the prototype detectors appear suitable to operate under the harsh environmental conditions of the large ocean depth and are soon expected to provide results on a range of geologically related phenomena, from natural hazards to geotracer circulation in the marine environment.

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S3-OP25

# αSPECT: Development of a novel radon detector adapted for operation in the marine environment

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RAMONES is an EU H2020 FET Proactive Project with the goal to develop a number of instruments to conduct continuous and in situ measurements of radioactivity in the marine environment, both natural and artificial [Mertzimekis, T.J. et al, 2021]. Proposed instruments consist of both a stationary benthic laboratory, housing a number of radiation detectors, and autonomous underwater vehicles (AUVs) equipped with γ-detectors with the task to perform spatially extended surveys, for radioactivity hotspot identification. Regarding naturally occurring radioactive material (NORM), and the characteristic decay series of uranium and thorium, radon and its isotopes 222,220Rn stand out due to their common chemical properties. Radon isotopes are the only gaseous products within each respective decay chain, and therefore, present vastly different transport properties, when compared to other products of said decay chains. Continuous monitoring of radon emissions has a number of applications in geosciences: It can be utilized as a potential earthquake precursor, and it has been associated with changes in volcanic activity [Barbosa, et al, 2015]. The purpose of the presenting work is to develop, test and characterize a novel radon detector, on the RAMONES benthic laboratory, with a design adapted to the limitations introduced by deep sea operation. The detection principle is electrostatic precipitation [Pereira, E.B. and Da Silva, H.E., 1989] of singly charged [Hopke, P.K., 1989] radon progenies onto silicon detectors, measuring subsequent alpha decays. The design of the detector is adapted to commercial, deep-sea cylindrical enclosures that will allow operation in harsh marine environments. The detector is under development, and the first tests are expected soon to begin.

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S3-OP26

# Methods for the detection and characterization of boat paint microplastics in the marine environment

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Microplastics in the marine environment have been the focus of intense research recently, however little attention has been given to boat paint sources, despite its direct influence on the marine ecosystem. This is largely due to the lack of established analytical methods. Microplastics from boating sources may originate from antifouling paints on the underwater body, surface coatings on the top sides, deck, and superstructure, as well as plastic parts of the boat construction. Their release can occur during construction, operation (leisure boats and commercial ships), service, and maintenance, from the materials themselves or used chemicals (e.g., abrasive detergents). Most importantly, boat paint microplastics containing biocides, such as the metals copper and zinc, and particles containing tin (residues from old or current use of tributyl-tin ship hull paints) should raise higher concern on potential environmental impacts. This study aims to provide practical insight on methods for the quantification of boat paint microplastics in marine waters and provide a baseline survey on their occurrence. Sampling and analysis methods are applied on case studies, i.e., marinas on the Swedish coast. A multi-method approach for identifying and characterizing boat paint microplastics based on visual and chemical characteristics is presented. In general, the measured content of biocide-containing microplastics was remarkably high in all marinas, with concentration levels of copper-rich particles >10 µm between 400 and 1400 particles per L. Given that biocide paint particles are manufactured to be toxic, it is particularly important to take into account field measurements in future environmental status assessments. This work underlines the importance of monitoring data in the action work between relevant authorities and stakeholders.

S3-OP27

# Stable thallium (Tl) isotopic signature as a green and potentially toxic elements source and migration tracer in the underwater Kolumbo arc-volcano, Aegean Sea

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One of the target settings to secure sustainable access to Critical Raw Materials (CRM), indispensable for Green Economy transition is metal(loid) resources in the submarine environment. Modern seafloor massive sulphide (SMS) deposits associated with arc-related hydrothermal vents are rich in critical and potentially deleterious metal(loid)s (PDM), e.g., Au, Ag, Cu, As, Sb, and Tl (Monecke et al., 2016). The deep-seafloor harbours hydrothermal ecosystems with unique biodiversity supporting vital biogeochemical cycles, e.g., C, S, and N (FFI, 2020), but also antibiotic and multidrug resistant bacteria (Bravakos et al., 2021). Consequently, the deep seafloor has triggered a heated debate whether CRM resource development is worth the ecological risk (Orcutt et al., 2020). Therefore, understanding the (bio)geochemical cycles, source(s) and liberation mechanisms of modern SMS-associated PDMs is crucial global necessity. To this end, we have used, for the first time, stable Tl isotope analysis of rhyolite pumice-hosted polymetallic SMS deposits from the Kolumbo underwater arc-volcano, a model volcanic-hydrothermal ecosystem that is influenced by geological and geochemical stressors (Nomikou et al., 2022), to fingerprint the source and migration pattern of Tl, and other PDMs in the Aegean Sea. Twenty Tl-rich sulphide-sulphosalt-sulphate samples from the Kolumbo polymetallic diffuser chimneys were analysed using bulk MC-ICP-MS for Tl isotope analysis, combined with LA-ICP-MS spot analysis for trace elements. The analysed samples contain primary As-pyrite rich in Sb (≤64,600 ppm), Tl (≤10,140 ppm) and Au (≤131 ppm), stibnite(Sb2S3) rich in Tl (≤21,800 ppm) and Au (≤64 ppm) and As-sulphides uniquely enriched in Tl (≤82,200 ppm), Sb (≤12,300 ppm) and Au (≤861 ppm), and belong to two sets: The first (n=13) comes from the interior parts, and the second (n=7) the exterior diffuser walls, and have ε205TlSMS values ranging from 0.02±0.7 to 6.96±0.7 ε-units, and –2.38±0.7 to 1.86±0.7 ε-units, respectively. The bulk (11 over 14) of the host-rock ε205TlRHYOLITE PUMICE values falls between −2.78 and -1.27 ε-units with an average of -1.43 ε-units, indicating a mantle source (-3>ε205TlDEPLETED MANTLE>-1) (Nielsen et al.,2017). We interpret the overlapping ε205TlSMS and ε205TlRHYOLITE PUMICE values around -3 to -1‰ as signifying a mantle source for the diffuser Tl. This is supported by δ65Cu ~0‰ in Tl-bearing chalcopyrite (unpublished data) consistent with δ65Cu values for mantle rocks (Berkenbosch et al., 2015), and vent fluids with MORB-like 3He/4He ratio indicating direct outgassing of mantle-derived volatiles (Rizzo et al. 2016). Thallium is correlated with Sb (R2=0.63%) and Mo (R2= 0.77%-82.2%), suggesting a common mantle source for Tl, Mo and Sb. Furthermore, mantle-derived Tl and Sb (As, Au) may be liberated due to Coupled Dissolution Reprecipitation (Putnis, 2009) reactions of early sulphide/sulphosalt phases with recurring magmatic vapours, and partly incorporated into reaction-produced sulphide/sulphosalt phases or lost in the water column. We suggest that active outgassing of mantle-derived volatiles and metal(loids) may cause the release of Tl, Sb, and As into the water column either directly through active hydrothermal diffusers or indirectly by hydrothermal reworking (CDR). The SANTORini's seafloor volcanic observatory (SANTORY) is using cutting-edge and innovative marine-technology to monitor Kolumbo's activity and mitigate potential ecological and health hazard.

S3-OP28

# Isotope-based early-warning model for monitoring groundwater - leachate contamination phenomena: A quantitative assessment

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The landfill is a typical solid waste disposal method in most countries and regions. However, unsuitable landfill management or ageing of its structures can drive leachate to flow into groundwater and change the chemical groundwater composition. Leachate is an effluent including organic matter and heavy metal ions, due to the impact of solid waste. Leachate causes modifications in the contents of anions and cations in groundwater and enriches the range of heavy metal ions, which can pollute groundwater. Common groundwater contamination includes heavy metals, nitrogen, fluoride, arsenic, and organic contamination. This is because heavy metal ions are difficult to biodegrade in groundwater circulation.
Additionally, because they are persistent, bio-accumulative, carcinogenic, and endocrine-disrupting, heavy metals can persist in degrading the groundwater environment and threatening human life and health. Deuterium (2H) and oxygen (18O) isotopes have been successfully applied to identify groundwater contamination processes due to interactions with municipal solid waste landfills leachate, including the significant organic amount. A parameter influencing the isotope content of deuterium and oxygen18 is the deuterium excess (d or d-excess). This paper presents a d-isotope-based model, defined early warning model, depending on assessing deuterium excess variations. This model provides the determination of an index, F, as the percentage variation of d-excess, which makes it possible to define an alert level system to assess and check groundwater contamination by leachate. The procedure shows that values of the F index higher than 1.1 highlight possible contamination phenomena of groundwater due to leachate. Therefore, actions by municipal solid waste landfill management are required. This early-warning model is presented by applying a case study in Central Italy to evaluate innovative aspects and opportunities to optimize the model.

S3-OP29

# Exploring Rare Earth Elements in Groundwater: Advancements in Analytical Techniques and Implications for Sustainable Resource Management

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Groundwater is an important natural resource that provides drinking water for millions of people around the world. Recently, there has been a growing interest in the presence of rare earth elements (REEs) in groundwater. These elements have unique properties that make them essential components in a wide range of technological applications. The occurrence of REEs in groundwater is of particular interest because it represents a potential new source of these valuable elements. Traditional sources of REEs, such as mining and processing of ores, are associated with significant environmental impacts, making the discovery of REEs in groundwater an attractive alternative. Furthermore, the presence of REEs in groundwater can provide insights into the geochemical processes that occur in the earth's crust. Despite the potential benefits, the presence of REEs in groundwater also raises concerns about the environmental and human health impacts of their extraction and use. However, the concentrations of REEs in groundwaters are very low (often below the detection limits) making them poorly considered.

We proposed an improved method for the determination of REEs in groundwaters, measured through inductively coupled plasma-mass spectrometry (ICP-MS) The samples underwent a selective enrichment process which is based on the coprecipitation of REEs with $Mg(OH)_2$, assisted by the triethylamine (TEA). The samples come from groundwater of the lower flanks of Etna Volcano (Sicily, Italy).

Our data show a general trend of the shale-normalized patterns, left-dipping with negative anomalies in Ce and positive anomalies in Y, highlighting a major complexation of the heavy REEs respect with to the light ones. The concentrations of REEs in Etnean groundwaters are totally controlled by the $HCO_3$- complexation. Moreover, the Y/Ho molar ratio, positively correlated with the total alkalinity of the samples, suggests a selective release of Y possibly derived by the dissolution of secondary calcite. Despite the low concentrations, the health risk for the population should not be underestimated, as we are dealing with drinking water. Further studies are still in progress.

S3-OP30

# A novel, robust field-sampling method for preserving dissolved mercury species associated with waters related to artisanal gold mining

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Mercury (Hg) is imported to Kenya for use in artisanal and small-scale gold mining (ASGM) at the rate of 6-45 tonnes per year and a significant portion of this is released to the environment through the mining activities. However, the ability to measure and identify Hg and its species in environmental matrices, in particular aqueous samples such as river and drinking waters, is challenging due to the poor availability of technologies to provide representative measurements of Hg. Concentrations of most Hg species significantly decrease in water samples within 1 week of sampling if not preserved appropriately, being lost predominantly to headspace and container materials. Current preservation methods are inadequate for field use, particularly in challenging environments such as ASGM sites. This leads to under-representation of Hg emission and toxicity in waters, used around ASGM sites for drinking, agriculture, and aquaculture.
Therefore, a robust method was necessary to provide measurements at sufficiently low Hg concentrations and avoid changes from field-collection to measurement, in particular where there is a delay such as from remote locations. The method must be sensitive, to provide useful public health and environmental regulatory information, and not require hazardous or expensive materials.
A novel field-based solid-phase extraction method was developed to preserve Hg species from water samples for up to 4-weeks after sampling. Both inorganic (Hg2+) and methylated (MeHg) species were preserved and recovered >90% from water samples after 4-weeks of storage (n=5).
This was then used to sample waters around ASGM sites in Kakamega, Kenya, as a proof-of-concept for the method.

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S3-OP31

# Prediction of ion adsorption by minerals using machine learning model

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The migration, distribution, and final fate of ions in the aqueous environment are largely controlled by the adsorption of iron minerals (e.g., goethite). Previous studies have carried out laboratory adsorption experiments on the adsorption of anions and cations by goethite under different reaction conditions, and a large amount of adsorption data has been obtained. The SCM (Surface Complexation Model), based on thermodynamic equilibrium theory, is an effective tool to investigate the partition of ions at the mineral-water interface. Unfortunately, the weak robustness of the model parameters may limit the predictive ability of the SCM for unseen adsorption data. Therefore, we propose another machine learning-based modeling approach that successfully achieves high accuracy predictions for six cations (Cd2+, Co2+, Cu2+, Ni2+, Pb2+, Zn2+) and five anions (SeO42-, SO42-, CrO42-, AsO43-, PO43-). The first hydrolysis constants of the ions can be used as distinctive descriptors to distinguish the adsorption behavior of various ions, according to the results of pH50-based feature engineering. After comparing 288 model scores and residual analyses for various input-output combinations, equilibrium concentration and fractional removal were determined to be the optimum input unit and output predicted target, respectively. Our research findings demonstrated the successful modelling of the absorption of metal ions on minerals using machine learning techniques, providing an alternative approach for predicting the migration and fate of elements in aquatic systems with wide application range and fast calculation speed.

S3-OP32

# Amazonian fog: An overview of the single particles within the flying river

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Amazonian fog plays a crucial role in the region's biodiversity, climate, and water cycle. The high amount of atmospheric water vapor creates a fog, which helps transport water vapor to other parts of the Amazon Basin. Fog is a vital source of nutrients for the growth and development of vegetation, including biogenic components, which are essential for nutrient cycling and carbon storage in the ecosystem. Understanding the dynamics of this process is essential for maintaining the integrity and functioning of the region. Chemical imaging and molecular characterization analytical facilities are used to analyze the morphology, chemical composition, hygroscopicity, and molecular chemistry of biological particles in the Amazonia region.

Representative samples of the natural fog composition in the Amazon Forest were collected at the pristine Atmospheric Tall Tower Observatory (ATTO) site in 2021. The sampling period was selected based on a prior visibility analysis that indicated the usual fog peak between 3 to 7 am. Liquid fog samples were collected above the canopy using the Caltech Active Strand Cloudwater Collector 2 (CASCC2) at 42 meters AGL. Samples of airborne particles were collected using a May cascade impactor, with aerodynamic diameter ranges from 0.5 to 4.0 µm maintained at a constant air flow rate of 17.5 L.min−1, installed at 42 meters. Ion Chromatography was used to investigate the cations and anions in the liquid fog, while Flow Cytometry was used to evaluate its microbiological activity. CCSEM/EDX was utilized for single particle analysis, defining clusters to identify Dust, Carbonaceous, Biological, Na-rich, Na-Sulfate, Sulfate, and other particles. Initial findings indicate a decrease in Na-rich compounds in all samples and sizes from pre-fog to fog time, probably as a result of their solubility in fog droplets. On the other hand, carbonaceous particles exhibit an increase, particularly in the finer fraction, during the same period. Biogenic particles were found mostly in the coarse mode, for which a decrease was noted for most samples. During high relative humidity, they usually have a big water uptake, making them heavier and more likely to deposit. So far, based on the data available, sodium and potassium are the most prevalent cationic species in the sample. Sodium is considered to have originated from seawater transport, while potassium is considered to have resulted from the breakdown of biogenic particles.

The results of the cytometry analysis indicate that the fog contains a significant number of cells, with a maximum count of 40,000 cells, requiring a careful metagenomic investigation to determine the sorts of biogenic material. Additional investigations will explore the single particles, metagenomics, and ionic composition of the fog. Understanding fog chemistry is essential for comprehending how its chemistry influences the forest ecosystem.

S4-OP33

# Review: Some pandemic RNA viruses emerge where geologic Se is unavailable to subsistence diets

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**Introduction:** Micronutrient selenium (Se) is an antioxidant. RDI values 55-70 mcg Se/day (US, UK) are optimal. Beck and colleagues (>1993) observed that Se-deficient human hosts infected with apathogenic strains of some RNA viruses (CVB3, IAV H3N2) became immunocompromised, and those 'benign' viruses mutated rapidly to virulence; she thought excessive physiologic ROS ($H_2O_2$), prompted by infection, induced immune dysregulation. Subsequent overlay of Oldfield's World Se Atlas (2002) with geographic origins of contemporary RNA viral infectious diseases (VIDs) correlated CVB3, IAV subtypes, and SARS-CoV1 with east China; HIV and EBOV, with northcentral Sub-Saharan Africa (Harthill 2011), all <0.1–0.3 mg Se/kg soil. Collegial discussion sought understanding causative factors supporting such correlations.

**Methods:** Literature review, assessment, and synthesis of geochemical and ecological field data (often SEGH citations) and biomolecular, etiological and epidemiological research provide the basis clarifying the Beck observations.

**Results:** Why Se? Human immunoproteins contain Cys residues (~2.2%). Cys-S- can become overoxidized, and dysregulating, by $H_2O_2$ generated by infection. Se, encoded in glutathione peroxidase-1 (Gpx1), reduces $H_2O_2$ to $H_2O$, i.e., no Se, no Gpx1, leading to overoxidized, inactivated Cys, impaired immunity and viral virulence causative to RNA VIDs. Further mapping of RNA viruses located endemic LASV in Nigeria, Guiana, Liberia and Sierra Leone; five originated within the East Africa Rift Zone: RVFV, WNV, CHIKV, ZIKV, and MERS-COV; and SARS-CoV2, genomically separate from other CoVs, emerged in central east China. Reported dietary-Se intake is <half optimal (Hurst et al. 2013; Xia et al. 2005).

**Conclusions:** Few data exist. Many questions remain, e.g., is micronutrient Se data worth pursuing? Beck et al. observed that dietary Se-supplementation to Se-deficient, RNA virus-infected hosts improved immunity and reduced virus mutation rates. China eliminated CVB3-induced cardiomyopathies with appropriate Se-supplementation (Xia et al. 2005). A 0.01µMol Se increase in infected Tanzanian host blood decreased risk of mortality from HIV-1/AIDS by 5% (Kupka et al. 2004). What percentage of >8M SARS-CoV2 related COVID19 deaths are due to communal sub-optimal Se status (Rayman 2001), or co-morbidity disease (cancers, diabetes) competition for limited host-Se levels?

S4-OP34

# Assessing geospatial controls on the soil-crop-health nexus in western Kenya

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Hidden hunger exists in many Sub-Saharan African countries where diets are dominated by maize, wheat, and cassava (~50-75% of calorific intake) thus lacking nutritional diversity[1]. Food insecurity and malnutrition are widely prevalent amongst Kenyan peri-urban communities, and previous studies have revealed a significant risk of deficiency (>90%) in the diet of western Kenyans for Se, Zn and Ca[2]. The variation of nutrient availability to crops is influenced by a large number of factors including soil physicochemical properties such as pH, organic matter and aluminium/iron oxide minerals. Previous studies in western Kenya have shown that the variance in maize element concentrations can be explained by soil predictor variables, accounting for up to 29% of the variance for Se[2]. Therefore, additional research into the physio-chemical properties controlling bioavailability is key for effective agronomic intervention strategies. To date total elemental concentration soil data has been used to create predictive maps highlighting the spatial distribution of chemical elements across western Kenya, providing a baseline for the agri-community, academics and public health officials[3]. However, further predictions are required to map the elemental concentration of staple crops which will provide critical knowledge for local farmers.

This research aims to investigate how the availability and transfer of essential elements from soils to crops will impact human health status in western Kenya. Here we show that the nutritional quality of staple crops varies geospatially in western Kenya and that understanding the variation of micronutrients is important at subnational scales. Assessing food and nutrition security is vital to address the UN sustainable development goals 2 (zero hunger), 3 (good health and well-being) and 15 (life on land). The data produced here feeds into a web tool that can inform policy decision-makers seeking intervention strategies addressing human health, food and nutrition security and conservation of the environment in Kenya.

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S4-OP35

# Evaluation of preliminary data from the pilot study for establishing the first Soil Geochemical Atlas of Hellas

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Soil, the foundation of our food systems, clean water and habitats is currently under increasing pressure; consequently, the protection, sustainable use and restoration of soil must become the norm. In this scope the long-term vision of EU for soil prescribes that by 2050 all EU soil ecosystems are in healthy condition (European Commission, 2021). Within this frame, geochemical atlases are excellent tools for a variety of applications by providing the necessary geochemical data needed for making decisions. In Hellas, national scale soil geochemical surveys have not yet taken place in a systematic manner. The goal of this project is to serve as a preliminary study on establishing the soil geochemical baselines of the pilot area (Attiki- Voiotia region), with the ultimate aim of publishing the first Soil Geochemical Atlas of Hellas, and create a rich, publicly available, database of soil geochemical data. The project is implemented by the Hellenic Survey for Geology and Mineral Exploration, Department of Geochemistry and Environment, through the National Funds Programme in collaboration with the Laboratory of Economic Geology and Geochemistry of the University of Athens. In the first stage a detailed sampling and analytical methods manual has been drafted. In the second stage, the methods have been tested in the field and the laboratory. A total of 164 top-soil and bottom-soil samples were collected from 117 locations on a 5 km x 5 km grid within the pilot area of about 2500 km2 by following and appropriately adjusting the guidance of the recently published International Union of Geological Sciences Manual or Standard Methods for Establishing the Global Geochemical Reference Network (Demetriades et al., 2022). The samples were dried, disaggregated and sieved to < 2mm and a portion of this was pulverized to <63 μm before chemical analyses to determine the concentrations of 51 elements by ICP-AES / ICP-MS following aqua regia dissolution, and physicochemical characterization (EC, pH, magnetic susceptibility). A sub-set of samples will be further characterized for particle size distribution, mineralogical analysis and leaching tests. In all stages a rigorous quality control procedure has been employed for the estimation of measurement uncertainty, including sampling and analytical blanks, duplicate samples/analyses and Certified Reference Materials. We will present the challenges of applying the protocols so far, along with proposals for the upscaling of the project to the national scale.

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S4-OP36

# Challenges of interpreting data of multiple-purpose geochemical mapping and surveying

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Multiple purpose geochemical survey sampling of stream sediment and floodplain sediment over the past decades in Hungary has produced large number of chemical data for major and minor components. In the beginning, mapping was carried out with the objective for mineral prospecting, but more recently, sampling was repurposed for mapping environmental pressures and characterisation of baseline conditions in the surface geochemical environment. Thus, the available national geochemical atlas provides information on the geochemical conditions on a national scale. It reflects both, potential toxicity due to environmental pressures and/or baseline (geogenic) geochemical conditions, such as an anomalous mineralization, for example. The atlas is based on low-density reconnaissance geochemical survey, later integrated with data from the different regional geochemical surveys, as well as floodplain sediment sampling along the major rivers.
Several challenges are encountered during the integration of data from the different sampling campaigns. These are related to the integration of survey data on different spatial scales (local, regional, national), and sampling density (low-density, or high-density), and also catchment based or linear water segment-based data. The sampling media is also being different, mainly stream sediment or floodplain sediment are sampled, however, spatially more variable soil samples are also collected in specific areas in order to increase sampling density. Additionally, problems arise from incorporating legacy data of variable quality.
Examples are presented using Hungarian data to highlight problems in multiple-purpose geochemical mapping with the focus on advanced statistical data processing and evaluation.

S5-OP37

# Air Quality at an International Airport in South Africa

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**Introduction**: Aviation traffic and airports are well-known anthropogenic air pollution sources which evidently impacts on the local environment and the health of airport workers and communities living close by. Monitoring and measuring air quality at most international airports is a challenge, mainly due to security issues and therefore literature on the matter is limited. Although international airports are mostly urban based, they are semi-isolated from other sources due to the vast area required and would be the primary source of measured concentrations. We report here on the air quality at a small international airport located in a rural area in South Africa, where several air pollution sources exist (the airport, aviation traffic, informal settlements, and veld fires. The latter both contribute to emissions from biomass burning and household combustion. Identification of the airport's footprint is thus the purpose of this investigation. Here we report on preliminary data.

**Method**: To assess the air quality at the airport, samples at four sampling sites were collected. Four two-week campaigns were conducted (2020 – 2021 therefore including different levels of lockdown during the Covid-19 pandemic) during which 24-hour PM2.5 samples on filters were collected. The filters were analyzed for mass concentrations, elemental carbon (OC and EC), and water-soluble cations and anions. SO2, NO2, and O3 levels were monitored through monthly passive sampling for 12 months (inclusive of PM sampling).

**Results**: Inorganic water-soluble profiles were mostly typical for South Africa except for significantly higher nitrate levels during winter. The Cation/Anion balance indicated neutral to basic air masses. The OC/EC ratio during all campaigns was larger than one and is indicative of aged air masses pointing to large regional influences. The 24-hour average PM2.5 mass concentrations during the 2020 autumn and 2021 spring campaigns did not exceed the current S.A. Air Quality guideline value of 40 µg/m3, but the new guideline (2030) of 25 µg/m3 is under threat. During the winter and 2nd autumn campaigns, however, it exceeded the current guideline by two orders of a magnitude. Ozone levels were measured monthly and can therefore not be evaluated directly against guideline vales, but the averages reflect the regional O3 problem in continental South Africa.

**Conclusions**: Increased PM2.5 mass, NO3-, K+, and Cl- concentrations and OC, EC levels during winter can be attributed to changes in meteorological patterns and source contributions, typically due to increased household combustion (informal settlement) and open biomass burning (veld fires). Mitigation steps and further investigations should be considered by airport management to reduce the air pollution footprint and improve air quality in the area. Furthermore, nearby informal settlements need to be supplied with renewable energy sources and open fires (for cooking or heating purposes) should be prohibited.

S5-OP38

# Oral bioaccessibility of potentially toxic elements in various environmental media

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An important aspect of the geochemical studies of urban environment is determining the possible adverse health effects of potentially toxic elements (PTEs) present in various environmental media. Data on total levels of PTEs alone is not enough for reliable risk assessment. Key information on PTEs behaviour in the human body in a case of their ingestion or inhalation can be provided with the use of in vitro bioaccessibility tests which simulate physiological properties of human organism in the laboratory. These tests give us information on how much of the analyzed PTEs dissolve in human body and are therefore available for absorption into bloodstream.

We analyzed oral bioaccessibility of As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Sn and Zn in various environmental media (soil, street, attic, household dust) collected from urban area of Maribor (Slovenia), by using the Unified BARGE Method (UBM). UBM simulates conditions and processes in human digestive tract by using synthetic digestive fluids. It gives us data on bioaccessibility of PTEs in two phases: gastric and gastrointestinal.

Bioaccessible fractions (BAFs) of PTEs vary significantly between individual samples of the same medium, between different media and between the two phases. In soil, attic dust and street dust, the bioaccessibility of individual PTEs is mostly higher in gastric than in gastrointestinal phase. The opposite is true for PTEs in household dust, as most of them have higher BAF in gastrointestinal phase than in gastric phase. In all four media, with the exception of Pb in household dust, among the most bioaccessible PTEs in gastric phase are Cd, Cu, Pb and Zn. During the transition from the stomach to the small intestine, the average BAFs of most elements in soil, attic dust, and street dust decreases. The most bioaccessible PTEs in gastrointestinal phase are Cu, Cd, Ni and As.

S5-OP39

# Resin supported nano-iron for the remediation of contaminated waters: The role of host resin matrix

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Resin supported nano-iron (R-nZVI) is a nanocomposite material with high potential for the remediation of contaminated waters. In this material the remediation potential of nano Zero Valent Iron (nZVI), which is based on the cooperation of multiple mechanisms, such as reduction, adsorption, or Fenton type oxidation, is combined with the cation exchange capacity of the supporting resin matrix. Many studies have demonstrated the effectiveness of this material for the removal of a wide variety of contaminants, such as chromates, heavy metals, dyes, pharmaceuticals, etc. However, the role of the host matrix on the effectiveness of remediation has not been yet systematically investigated. This is an aspect particularly important during the treatment of natural waters or typical wastewater streams, where major background cations and anions compete with the target contaminants for the available cation exchange and/or adsorption sites. In this study, two different types of cation exchange resins have been evaluated as host matrices for the synthesis of R-nZVI, (i) a strongly acidic resin with sulfonic acid functional groups (Amberlyst 15 H+) and (ii) a chelating resin with iminodiacetic acid groups (Amberlite IRC748). The performance of the two nanocomposites has been evaluated for the remediation of metal contaminated waters. To simulate the composition of typical aquatic streams, the background solution consisted of the tertiary effluents of a wastewater treatment plant diluted by 50% with deionized water and artificially contaminated with Cr(VI), Cu, Cd, Ni, Pb and Zn, which were examined as typical metal contaminants.

S5-OP40

# Soil geochemical spatial distribution trend of heavy metals in the Kimmeria Public Mining Area, Northern Greece

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Heavy metals are released into the environment by both natural and anthropogenic sources and can potentially be toxic. Many of these metals are enriched in areas hosting ore deposits; their spatial distribution trend is critical for evaluating the environmental impact. This study records the soil geochemical signature in the southern part of the Public Mining Area of Kimmeria, northern Greece, and aims to form the basis of an integrated geochemical baseline study, prior to any future mining activities.
The study area lies within the Rhodope Massif and hosts the Kimmeria magmatic-hydrothermal system, which is associated with the Xanthi pluton. It comprises two major ore types: i) a Fe-Cu±W±Bi±Mo±Au skarn and ii) a Mo-Cu±Au vein-hosted mineralization, mostly concentrated in the northern edge of the study area. Fourty-six surface samples (0-20 cm depth) were collected, covering an area of about 2,5 km², and detailed mapping of the existing environmental pressures was carried out. The contents of As, Bi, Cr, Cu, Mn, Mo, Ni, Pb, Sn, W, and Zn were measured using ICP-MS, while $Fe_2O_3$ values were obtained by XRF at the analytical laboratories of HSGME. Statistical analysis and spatial interpolation were performed using Microsoft Excel 365 MSO and ArcGIS 10.8.1 software.
The spatial distribution patterns reveal certain groups of elements, i.e., $Fe_2O_3$-Cu-Bi-W, Mo-W-Zn, that display significant to very strong positive Pearson correlation coefficients (e.g., Bi-Cu, Bi-W, Mo-W, Mo-Zn, Cu- $Fe_2O_3$, and Mn-Zn). These groups reflect the availability of these elements with respect to the major types of mineralization, with relevant spatial and linear trends. These data suggest common geological sources, also supported by the mineralogical and mineral-chemical remarks. Notably, As exhibits poor correlation suggesting spatially controlled factors (e.g., substituting element in minor phases like pyrite).
Samples and data analysis are still in progress and the final trends are expected to be delineated.

S5-OP41

# Recycling of Waste Electronic & Electrical Equipment (WEEE): Scope to improve productivity and safety in the informal sector, a case study from Port Harcourt, Nigeria

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The global flows and management of WEEE also controls the flow of many critical and precious elements, lost from the global economy with recent values at >$62 billion (WEF 2019). The WEEE mountain is predicted to hit 120 million tons by 2050. High level policy in many regions looks to stimulate more circular electronics systems recovering and re using primary materials and offering rental or leasing to maximize recycling and product use. Currently much of this waste is landfilled or informally processed in developing countries, by informal pickers.
Annual WEEE management in Nigeria is over 1.1 million tons from domestic and (often illegally) imported materials, with <1% subject to documented management and recycling. Recently the Nigerian Government has established a fund to formalize the waste picker role and safeguard work. We report on a study of waste pickers and waste operatives at an informal WEEE recycling activity in Port Harcourt, Nigeria. The activities of the waste pickers were assessed during field visits and through questionnaires and semi structured interviews designed to profile the activity and experience of the group as well as their knowledge and opinion on ways to improve working conditions. Responses were obtained from manual workers, waste managers and government employees.
The responses were predominantly from men, working in the sector for more than 5 years, >50% between 35 and 50 years old. Most worked informally because of the absence of other opportunities and identified manual dismantling and burning of plastic materials as a common method to collect valuable materials. There was some concern that a mix of near end of life devices with WEEE created problems with equipment sale for re-use versus resource recovery operations. The absence of environmental and occupational health and safety systems was acknowledged, and the respondents identified a range of poor practice and lack of infrastructure support. Support was given to proposals to manage WEEE handling and disposal with government incentives, restricting hazardous practice. The introduction of concepts to apply lean processing principles to improve device throughput and reduce exposure to potentially harmful substances was welcomed by the respondents. Ultimately the study identified tangible routes to improve conditions of waste pickers.

S5-OP42

# Actinides in crystals of critical minerals

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The presence of actinide elements (mainly U, Th) in crystals of minerals containing 'critical' metals -i.e. critical minerals- was investigated. The foremost purpose was to evaluate the potential natural radioactivity of these inorganic geomaterials. The samples included: a) REE cyclosilicate (eudialyte group) crystals from Greenland (Kingdom of Denmark) and Kola peninsula (Russia), b) REE fluorocarbonate (parisite & bastnäsite group) crystals from Montana (USA) and Madagascar, c) U-bearing Nb (Ta)-oxide minerals from Madagascar and Norway, d) V-U minerals from Dakota (USA). The minerals were characterized by powder-XRD, SEM-EDS, and Mössbauer spectrsocopy. Bulk analyses, concerning actinides, were performed by means of ICP-MS, whereas point analyses and mapping by Synchrotron radiation □-XRF and LA-ICP-MS. Furthermore, high-resolution □-ray spectrometry was applied, in respect of radioactivity measurements. The V-U minerals (carnotite group) are, obviously, highly radioactive, although the bulk actinide content of the host-rock -sandstone- is rather low. Some REE fluorocarbonate minerals, comprising a major source of REE worldwide, are remarkably radioactive due to Th, while the U content seems to be lower but significant. Concerning eudialyte crystals, showing also enhanced importance in the mining industry, the Th content was found to be lower than U, both between ca. 10-120 ppm according to bulk and point analyses. The U-bearing Nb (Ta)-oxide minerals (columbite, samarskite, betafite, fergusonite) exhibit notable natural radioactivity, as well. The results of the present investigation may contribute to environmental mineralogy and geochemistry aspects of critical metals & minerals exploitation in the world.

S5-OP43

# Lanthanoid geochemistry in rainwater from rural, urban, industrial, and volcanic areas of Sicily, Italy

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Despite only a few studies on the concentration of the lanthanoid elements (from La to Lu) in rainwater are available in the literature, their significant environmental impact has been recognized. Shale-normalized lanthanoid patterns are used to determine the source of these elements in rainwater. Lanthanoid concentrations were measured in 74 rainwater samples collected, from March 2021 to November 2021, at 15 sites in Sicily, located in different contexts: rural (Nebrodi), urban (Palermo and Catania), industrial (Milazzo and Priolo Gargallo) and volcanic (Etna). Rainwater samples were collected using bulk collectors and underwent a pre-concentration procedure, according to Arslan et al., 2018, before analytical determination by ICP-MS (Agilent 7800ce). The concentrations in rainwater samples were variable, with the total dissolved lanthanoids (TDLs = Σ of lanthanoids) and the TDLs increased with decreasing pH values ($r = 0.611$, $p < 0.0001$). Median concentrations of 29 ng/L, 42 ng/L, 51 ng/L, 66 ng/L, 67 ng/L, and 74 ng/L were measured for Milazzo, Nebrodi, Palermo, Catania, Priolo Gargallo, and Etna, respectively. Lanthanum concentrations were elevated in all the sampling sites, reaching median La/Ce ratios up to 3.80 for the Priolo Gargallo industrial area. The source of the La enrichments in urban areas may be due to the vehicular traffic (automobile catalysts), while for both industrial areas, the sources may be related to the traffic emissions and, given the emissions from the combustion of fuel oils from the power plants (low La/V ratios: 0.06 for Priolo Gargallo and 0.02 for Milazzo). Small La enrichments, sometimes accompanied by Eu enrichments, had also been observed at Nebrodi and Etna, and possible sources were the crustal source and the volcanic emissions, respectively. This study confirmed that lanthanoids in rainwater can be a valuable tool to discriminate the various sources of anthropogenic pollution.

S5-OP44

# Retention of lead by olive-mill wastes derived biochar through batch experiments and geochemical modeling

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The degradation of land and water due to contamination by potentially toxic elements has been a crucial research topic. Within the sustainability framework, biochar's derived from agricultural residues have effectively been applied as remediation agents, due to their versatility, abundance, and cost-efficiency (Jellali et al., 2021). This study examined the efficiency of olive-mill wastes derived biochar in removing lead (Pb) from aqueous solutions under batch adsorption experimental conditions. The mechanisms controlling the Pb-biochar interactions were investigated by geochemical modeling using PHREEQC code. The applied biochar was prepared by pyrolysis of the feedstock material at 500oC and is characterized by alkaline pH (9.5) and high surface area (166 m2/g). Calcite, sylvite, and quartz were the main crystalline phases of the biochar (El-Bassi et al., 2021). The adsorption results showed that adsorption is a relatively fast process, since more than 70% of Pb was removed within the first 2hrs of the experiment. The higher adsorbed Pb amounts (~43 mg/g) were observed at high biochar dose (4 g/L) and at initial solution pH ~5. The formation of hydro/cerussite was also identified onto the biochar surface after the adsorption experiments. The geochemical modelling employing the PHREEQC code showed that ion exchange and precipitation of Pb-rich phases are the main reactions controlling Pb removal from aqueous solutions, whilst surface complexation is insignificant, mainly due to the low surface functional groups on the applied biochar. Furthermore, the numerical model was applied to assess the potential use of biochar in the treatment of selected contaminated soils (Kypritidou & Argyraki, 2020). The model results showed that the effectiveness of biochar increases in alkaline soils, due to formation of Pb-rich stable phases. Overall, olive-mill waste derived biochar can be considered as a cost-effective and environmentally friendly material, not only as a slow-release fertilizer but also as a remediation agent of contaminated porous media.

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S5-OP45

# Distribution and transformation of inorganic sulfur in sulfide mine taillings

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Sulfur biogeochemical processes in metal-sulfide mine tailings affect the release and migration of heavy metals, which is related to the downstream environment and human health. To better understand the source, composition, and transformation of sulfur, we collected tailing samples from two sediment profiles (CDK and S0) of a typical metal-sulfide mine located in north of Guangdong, south China. A modified method to extract elemental sulfur (ES), acid volatile sulfide (AVS), chromium reducible sulfur (CRS) successively was developed, and sulfate was divided into water soluble sulfate (WSS), exchangeable sulfate (ExS), and acid soluble sulfate (ASS) after rinsing using different solution, so as to characterize the distribution of sulfur species and its isotope composition.
Results showed sulfate was the main existence in CDK and S0, and sulfur isotope ratio between sulfate and original ore was similar, indicating sulfate originated from the oxidation of sulfide mineral. However, sulfate species were different in both sites. About 55% sulfate were WSS in CDK, while 68% were ASS in S0. Besides, ASS in S0 depleted more 32S than CDK, implying the formation of sulfate mineral was more active in S0. Moreover, reduced sulfur species were more abundant in S0, and sulfur isotope fractionations between AVS and CRS (Δ34SAVS-CRS) of up to -29.8‰ in S0, indicating intense bacterial disproportionation and sulfide oxidation. Specially, δ34SCRS homogeneously ranged in -0.9‰ ~ 0.1‰ when CRS was more than 250 mg/kg, while low CRS content was corresponding to more negatively δ34SCRS values, implying there existed a conversion from FeS to FeS2. The findings of this study provide insights into the sulfur biogeochemical process in metal-sulfide mine tailings.

S5-OP46

# Is alkali activation of mixtures of marl and slag or metakaolin a feasible option for the stabilization of clayey soils?

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The most commonly used binders for soil stabilization are Portland cement and lime. However, due to the high carbon footprint of cement production recent research efforts focus on the use of other environmentally friendly binders. The present study aims to assess the alkali activation potential of mixtures of marl and slag or metakaolin, at various ratios, for the stabilization of clayey soils. The slag used in the present study was produced from an electric furnace during the production of ferronickel (FeNi) at 1450 $^{o}$C. Metakaolin was produced from the calcination of kaolin at 750 $^{o}$C. The activating solution used was a mixture of NaOH and $Na_2SiO_3$ solutions. Control specimens from the alkali activation of only marl were also produced.
The effect of various operating parameters, including the molarity of NaOH (2 to 8 mol/L, M) which affects the $H_2O/Na_2O$ and $SiO_2/Na_2O$ ratios present in the activating solution, curing temperature (25 to 80 $^{o}$C), curing period (0 - 24 h) and ageing period (7 to 28 days) on the compressive strength of the produced alkali activated materials (AAMs) was explored.
The experimental results indicate that alkali activation of mixtures of marl with slag or metakaolin at ratios 70:30 is a feasible option for the stabilization of clayey soils and the produced specimens acquire compressive strength that exceeds 15 MPa.
Mineralogical analysis (XRD), Fourier transform infrared spectroscopy (FTIR), mercury intrusion porosimetry (MIP), scanning electron microscopy (SEM) and thermogravimetric (TG) analysis were used to elucidate the microstructural characteristics of the produced specimens and the chemical reactions that took place during AAM synthesis.

S5-OP47

# Unnatural cycles: Anthropogenic disruption to health and planetary functions

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Natural cycles such as the hydrological, nitrogen or carbon cycles underpin the very stuff of life. Unnatural cycles are anthropogenic activities which have a circularity, but which have a detrimental effect on human (or other) health, exacerbating existing problems.
Natural cycles have feedback loops, some of which have only recently been understood. In biological systems, feedback loops are imperative in maintaining homeostatic mechanisms. However, in an unnatural cycle, the feedback loops serve to reinforce (and may amplify) negative problems which can have adverse outcomes at various levels from the individual to the global.
We demonstrate an unnatural, anthropological cycle, moving from air quality to lung function and back to air quality: we call this the 'lung disease unnatural cycle'. Links exist between air pollution, asthma, aerosol inhalers, greenhouse gases and resulting reduced air quality. Disposal to landfill of the inhaler units means new ones need to be manufactured, giving rise to further mining, plastic production, degraded water quality and transport issues with further impacts on air quality.
Wider consideration of interactions between various industries could lead to breaking this unnatural (or vicious) cycle, changing it to a healthy cycle where individual health can be improved, along with better global scale outcomes. Many activities within this unnatural cycle occur within silos. However, the improved (or repaired) cycle incorporates joint activities at geological, health, and financial levels, to the mutual benefit of all, breaking the unnatural cycle and improving health, life, and financial costs.

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S5-OP48

# Assessing the quality of sediments in streams draining contrasting land use areas: Case study of Osogbo Metropolis, Southwestern Nigeria

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The attendant effects of urbanization on the environment and human health are measurable by assessing the potentially harmful element (PHE) concentrations in environmental media such as stream sediments. This is because stream sediments serve as sinks receiving materials from upland areas. In order to evaluate the effect of urbanization in Osogbo Metropolis, the quality of stream sediments draining a densely populated area characterized by commercial activities was contrasted with those from a sparsely populated area with minimal anthropogenic input.

A total of 40 near-surface sediment samples were obtained: 29 samples from Okoko stream draining a densely populated area categorized as Zone 1 (n=14) and Zone 2 (n=15), and 11 samples from Omu stream draining a sparsely populated area (Zone 3). The sediments were air-dried, sieved to <75-micron fraction, and analyzed for PHE concentration using inductively coupled plasma atomic emission spectrometry (ICP-AES). Ecological indices such as contamination factor (CF) and degree (CDeg), enrichment factor (EF), index of geoaccumulation (Igeo), pollution index (PI), and ecological risk factor (Er) and index (ERI) were used to assess the quality of the stream sediments. The inter-elemental relationships and source identification were done using Pearson's correlation matrix and principal component analysis (PCA).

The PHE concentrations in the sediments were in the order; Zone 1: Zn>Pb>Cu>Cr>Sr>Ni>Co; Zone 2: Zn>Cr>Ni>Co>Pb>Cu>Sr, and Zone 3: Zn>Co>Cr>Cu>Sr>Ni>Pb. CF values for Zone 1 sediments revealed at least moderate contamination by Cu, Pb and Zn; moderate Pb and Zn contamination in Zone 2 while Zone 3 sediments were moderately contaminated with Co and Zn. Igeo and EF calculations revealed moderate to strong pollution of Cu, Pb and Zn in parts of Zone 1, moderate to strong pollution of Zn in Zone 2 while Zone 3 had moderate pollution of Co and Zn. PI values revealed that sediments of Zone 1 are extremely polluted, while those of Zones 2 and 3 are moderately and slightly polluted, respectively.

The contamination of the sediments in Zones 1 and 2 by Cu, Pb and Zn is adduced to anthropogenic activities such as vehicular traffic, automobile repairs/painting, and blacksmithing/welding. In Zone 3 however, elevated concentrations of Co and Zn resulted from the application of herbicides/pesticides and fertilizers for agricultural purposes.

# POSTER / FLASH PRESENTATIONS

S1-PP01

# Spatialized PM2.5 during Covid-19 pandemic and the health data in Brazil's largest southern city

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Brazil has one of the highest COVID-19 fatality rates worldwide, with over 320 deaths per 100,000 people and over 600,000 reported deaths, a number surpassed only by the United States. Despite efforts to curb the pandemic, multiple waves reported of infection have emerged in different parts of the world. Although several studies suggest that air pollution, particularly fine particulate matter (PM2.5), can exacerbate SARS-Cov-2 infection, most research has been conducted in Europe, the United States and China, correlating a set amount of pollution with a vast geographical area. In the context of air pollution in Brazil, nearly 61,000 people die annually due to exposure to PM air pollution. In Curitiba, a capital city in the southern region, air pollution and monitoring has been a long-standing problem. During the COVID-19 pandemic, with restrictions on mobility and industrial activities, air pollution levels in Curitiba initially decreased. However, as restrictions eased and people resumed their daily routines, pollution levels began to rise again. It is important to note that air pollution is not a direct cause of COVID-19 but can exacerbate the severity of the disease. Therefore, addressing air pollution issues in different contexts, such as the ongoing COVID-19 pandemic and other cities worldwide, improves public health and reduces the burden on healthcare systems. This research aims to investigate the regionalized association between exposure to PM2.5 air pollution and its health impacts on a Brazilian town, specifically the susceptibility to COVID-19. To accomplish this, the pollution level was evaluated using spatial interpolation techniques in a geographic information system (GIS) based on in-situ PM2.5 measurements. This technique enables the analysis of the spatial distribution of air pollutants, allowing the identification of trends and areas with high pollution levels. A low-cost sensor network collected data from 9 regions in Curitiba and its metropolitan industrial counterpart, Araucaria, both significant cities in the state of Paraná. Based on the relative risk methodology, it was found that the lowest and highest PM2.5 concentrations increased mortality relative risk by 0.8% and 5.8%, respectively. Additionally, it was estimated that PM2.5 contributed to 3% to 5.4% of natural deaths in the studied cities in 2021, with Araucaria being the location most affected. The study also identified a positive and significant correlation between COVID-19 mortality and incidence in more polluted places ($r$ up to 0.36, $p$-value<0.01) and during winter months ($r$ up to 0.40, $p$-value<0.05). The findings demonstrated the significance of regional differences in air pollution spatialization in determining the health effects of PM2,5. Although the region analyzed had lower rates of COVID-19 compared to other regions, air quality has been found to play a significant role in exacerbating the disease. The results suggest that air pollution can significantly impact the severity of COVID-19 outcomes, even in regions with lower infection rates.

S1-PP02

# Chromium and Diabetes: A systematic review of environmental health literature

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**Introduction**: Diabetes is a global public health concern with increasing prevalence worldwide. Chromium, a trace element found in soil, water, and food, has been proposed to have a potential role in glucose metabolism and diabetes prevention. However, the relationship between chromium exposure, mainly through the consumption of diet supplements, and diabetes remains controversial.

**Methods**: We conducted a systematic review of the current literature, on the PubMed database from January 1, 2021, to December 31, 2022, using specific keywords and inclusion and exclusion criteria on the link between chromium exposure and diabetes. After screening 63 studies, 12 were included in the final review, which was evaluated for quality and relevance, with appropriate quality assessment tools.

**Results**: Our review found mixed evidence on the association between chromium exposure and diabetes. While some studies reported potential benefits of chromium supplementation in reducing blood glucose levels and improving insulin sensitivity, others showed no significant effect. Additionally, some studies have investigated the relationship between chromium exposure and the incidence of type 2 diabetes mellitus (T2DM) and have found that higher chromium exposure may have a protective effect against T2DM. However, more research is needed to fully understand chromium's potential benefits and risks regarding its mechanisms of action in the body.

**Conclusions**: The findings of this systematic review suggest the need for additional research to fully understand the role of chromium, regarding the type and exposure route, in the prevention and treatment of diabetes. While there is some evidence to propose that chromium supplementation may have benefits for managing diabetes, high levels of exposure may pose a risk. This review highlights the importance of considering environmental factors, such as exposure to trace elements, including chromium, in understanding the complex etiology of chronic diseases.

S1-PP03

# Integrating health and environment: A medical perspective

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The health threats from emerging pollutants can initially appear difficult to manage. However, there are well established approaches to the environmental-health interface which can be applied with confidence.

Working with other professionals in a multi-disciplinary approaches, using different aspects of science and building on high-quality environmental investigations, enables us to manage complex and uncertain situations, including ones not faced before. Environmental decisions, whether remediation of contamination land, or responding to threats from emerging pollutants in land, air or water, are often based on existing or modelled health outcomes. High quality, accurate environmental investigations into pollution and other environmental issues enable us to better understand the likely health outcomes, and hence to develop appropriate responses.

Environmental scientists need a basic understanding of health issues in order to respond appropriately to disease and risk. Factors affecting health ('determinants of health') operate at different levels, from the individual's genes to the international level, often with several levels acting synergistically. Pathways, exposure, dose and individual receptor response also vary, modifying certainty. An integrated, multi-agency public health risk assessment enables varying source-pathway-receptor issues to be reviewed together to build a robust response.

Improving the health of a community often requires different approaches and efforts to those required to improve the health of an affected individual. Balancing these approaches takes patience, skill, knowledge and humour. However, these efforts are not sufficient on their own, needing careful integration with the wider context and stakeholder agendas, without which any response to the environmental assessment may very well fail.

Such proven, integrated environmental approaches are likely to benefit more people than any other health-improvement strategy.

[Stewart AG. Hursthouse AS. Environment and human health: the challenge of uncertainty in risk assessment. Geosciences. 2018; 8(1): 24. https://doi.org/10.3390/geosciences8010024]

S1-PP04

# The iron ore handling in the Tubarão Port Complex-brazil: PM2.5 resuspensions over the Vitória City

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Tubarão Port Complex in Brazil is a major hub for the handling and exporting of iron ore, one of Brazil's key commodities. The port complex is located in the city of Vitória in Espírito Santo State, where the ore is loaded onto ships for export to various countries worldwide. Loading iron ore onto ships may emit and resuspend PM2.5, affecting the population of the nearby city. This study aimed to provide an initial assessment of emissions to Vitória by examining the PM2.5 pollution levels generated by mining and steel port activities such as iron ore shipping, storing, loading and unloading. To achieve this, the researchers employed multiple techniques, including gravimetry, X-ray fluorescence analysis of PM2.5 samples, and an optical transmissometer. The results indicated a notable presence of anthropogenic activities observed in both external and indoor environments. Vehicular and mining-steel sources were identified as the major sources of pollution, with an average concentration of 5.7 µg.m-3 in the external environment and 6.5 µg.m-3 inside residences. The analysis of 114 samples revealed that 65 per cent had an I/O ratio greater than 1, indicating that the interior air quality was inferior to the outdoor air quality. The health risk assessment indicated a negligible risk for non-carcinogenic effects. However, there was a risk of 100 people in 1,000,000 developing cancer over their lifetime due to exposure to PM2.5, with 81 cases attributed to exposure to Cr (VI). Our findings suggest that the activities at the Tubarão Port Complex significantly impact the emission and/or resuspension of PM2.5 particles into the local atmosphere. This study highlights the critical importance of implementing effective mitigation strategies and activities to improve air quality to protect public health.

S1-PP05

# Adsorption studies of emerging contaminants on Spanish Mg-clays

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Emerging contaminants occur in the environment as a consequence of their wide use in veterinary and human health and because water treatment plants are not design to take out these chemicals. Among the additional processes studied to eliminate these compounds, adsorption is widely used. Clay minerals, mainly smectites and sepiolite, have shown good adsorption performance in the removal of many organic compounds. In this work, after previous characterization, eight raw Mg-clays from the Madrid Basin (Spain) were evaluated as adsorbents of two organic compounds in order to establish new applications for them.
All materials were assessed as adsorbents of ciprofloxacin (CPX) and lidocaine (LID) considered as emerging contaminants. Adsorption experiments were conducted by batch sorption tests mixing 0.02 g of adsorbent with 8 mL of contaminant solution and stirring at 20 °C until equilibrium was reached. Adsorption kinetics studies showed that in all systems the equilibrium is reached within a contact time of 20 min.
Adsorbent clays were chosen considering their mineralogical composition and different textural and physicochemical properties. Four groups were differentiated and identified as: Pal (palygorskite), Sap (saponite), KS (kerolite /stevensite), and Sep (sepiolite). All materials showed higher adsorption capacity for CPX than for LID which could be associated with their molecular sizes. The higher CPX adsorption capacities were obtained for Pal and Sep (7.76 and 5.18 mmol.g-1, respectively) evidencing that fibrous clay minerals favors CPX adsorption. For LID adsorption, the highest value was obtained for Sap (0.48 mmol.g-1) and followed by Pal (0.41 mmol.g-1) and these results are according to their CEC, suggesting that the adsorption would occur mainly by a cation exchange mechanism in this case.
The analyzed clays can be good adsorbents of both molecules, evidencing a new application for them. The obtained results are fundamental when considering them as low-cost geomaterials for environmental applications.

S1-PP06

# Leachability of chromium from fly ash-marl mixtures in Sarigiol basin, Western Macedonia, Greece: Potential environmental and health hazard

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**Introduction**: Hexavalent chromium (Cr(VI)) is a toxic, mobile environmental contaminant that's concerning due to its higher toxicity and mobility compared to Cr(III). Cr(VI) has been linked to several adverse health effects, including respiratory diseases, lung cancer, and skin irritation. The primary sources of it in the environment are industrial activities, such as the mining and processing of chromium-containing minerals. The objective of this study is to investigate the concentrations of Cr(VI) in leachates of fly ash and marl mixtures and determine its solubility under different pH conditions.

**Methods**: To conduct this study, samples of fly ash from the Power Plant Agios Dimitrios and marl from the mine of South Field were collected, and mixtures of these were prepared in different proportions (% w.t.). The leaching experiments were carried out according to the EN-12457/1-4 (2003) standard under different pH conditions and chemical analysis of the leachates were performed by atomic absorption spectroscopy. The concentrations of Cr(VI) were determined spectrophotometrically at 540 nm with the diphenylcarbazide indicator according to the reference method 3500-Cr B.

**Results**: The leachability of chromium, especially its hexavalent form, varies with the pH and percentage participation of starting materials. The environmental footprint of chromium in the study area is significant, especially in mixtures containing higher concentrations of fly ash.
The pH level has a crucial role in the leachability behavior of chromium. A critical pH range between 6 to 12 is observed, with high pH conditions enhancing the leaching of total chromium. In the present study, at acidic pH values, a high release of Cr(VI) is observed, while at the mentioned critical values (pH 10-12), a gradual decrease in its leachability is observed.

**Conclusion**: High concentrations of Cr(VI) in the studied industrial area require action to manage and mitigate potential impacts on the environment and by extension on public health. Further research is required to fully understand the extent of the potential risks associated with chromium exposure, and the development of appropriate strategies for prevention.

S1-PP07

# Quality criteria control study of Estonian curative mud

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Curative mud, or therapeutic mud, is a type of sedimentary deposit that has been used for healing purposes since ancient times. With its unique geological and geomorphological characteristics, Estonia has the most significant resources for health and wellness tourism among the Baltic countries and Scandinavia.
The sustainable and skillful use of curative mud offers more environmentally friendly alternatives to synthetic, imported medical or cosmetic products, as curative mud is used as a local natural resource. Despite regulations in place for the marketing, storage, and use of curative mud, there are currently no requirements for ensuring safety criteria such as permissible levels of hazardous chemicals and microorganisms.
The Centre of Excellence in Health Promotion and Rehabilitation (TERE centre) is a centre for promoting and advancing research and development and mediation in the fields of curative mud treatment and human mobility and operational capacity. The geochemistry of curative mud is complex and varies depending on the location and geological conditions under which it was formed. However, the high concentration of minerals, trace elements, and organic matter found in these muds is believed to have a beneficial effect on the skin and can help to promote overall health and well-being.
In 2022, the curative mud study aimed to determine and map the condition of Estonian curative mud deposits and to control the proposed new quality criteria for Estonian curative mud. The study mapped the spatial distribution of the lithological composition of the mud, as well as hazardous substances in the surface sediments of Estonian curative mud deposits in Haapsalu Bay, Käina Bay, and Värska Bay (Lake Peipsi). The study also compared its results with earlier investigations, as well as with Estonian and international reference values for soils and sediments.
The Värska curative mud deposit had the highest organic content (37.3%), while the Käina curative mud deposit had a high mineral content (92.3%). Pesticides were found in five samples from the Värska Bay. The concentration of phenolic compounds in all three deposits was below the detection limit, except for the Värska Bay (4-methylphenol). The results of the heavy metal analysis confirmed that the concentrations of heavy metals found in all three curative mud deposits were within permissible limits. The content of petroleum products in the Haapsalu Bay was on average 42 mg/kg, while in the Värska Bay it was 118.6 mg/kg dry weight.
Further work will be devoted to establishing the structure of the mineral matrix of the muds, to better understand the significance of increased concentrations of some heavy metals, as well as to analyze the chemical nature of the organic compounds present in the muds and their correlation with the curative properties of the muds and therapeutic peat. The release of the toxic elements and some important therapeutic properties depend mainly on geochemistry, which is underlined in the development of fields of curative mud medicine.

S1-PP08

# Hydrogeochemical assessment of thermal springs in Kos and suitability for healing purposes

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Natural hot springs in western Kos occur due to the geothermal activity in the wider area. The aim of this study is the determination of the concentrations of the major elements and trace metals in order to assess the origin of water and its potential use for healing purposes. Samples were collected from 4 springs in the coastal zone of western Kos during the wet period of April 2022 and dry period of September 2022 . In each location, physicochemical parameters were measured in situ (T, pH, E.C., DO,
TDS, Eh, At). Major elements and trace metals were analyzed in the certified aboratories in the National Institute of Geophysics and Volcanology in Palermo, Italy, the Mediterranean Institute of Oceanography in Marseille, France and the National and Kapodistrian University of Athens, Greece. "Embros Thermi"- St. Foka spring is characterized as hyperthermic and acidic, "Piso Thermi"- St. Irini spring as homeotherm and slightly acid-neutral, "Kokkinonero" spring as hypothermic and acidic and "Coastal
cold spring" as cold and alkaline. They are enriched with trace metals and elements, which are released during the interaction of geothermal fluids with the surrounding volcanic rocks. In particular, high concentrations of Fe, Li, Sr, Mn, As and Cs are observed. The hot springs "Embros Thermi" - Ag. Foka as well as "Piso Thermi" - Ag. Irini are of Na-Cl type , with high concentrations of Ca (+2) , Mg (+2) and SO4 (-2) . These ions contribute to the healing of rheumatic diseases, arthritis diseases of the nervous system when used in bath therapeutic purposes (Erfurt, 2021; Atman , 2000) . Therefore, the springs “Embros Thermi” - St. Foka and "Piso Thermi" - Ag.Irini are recommended for the treatment of the mentioned diseases however the exposure time is also a parameter that has to be taken into account.

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S1-PP09

# Heavy metal adsorption efficiency of natural manganese oxides

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**Introduction:** Manganese oxides are recognized as one of the most important scavengers of aqueous trace metals due to their physicochemical properties and structure. The framework of these minerals consists of Mn-O octahedral that share edges and link corners to construct tunnels and layers. Manganese oxides with tunnel structures are of particular interest because they exhibit a range of tunnel shapes and sizes which can contribute to a range of complementary catalytic or cation-exchange applications.

**Methods & Results**: The natural Todorokite and ramsdellite used in this study were sampled from the area near Kato Nevrokopi (Drama, N. Greece). The samples were analyzed for their mineralogy by X-Ray diffraction (XRD) combined with Fourier-transform infrared spectroscopy (FTIR). The bulk chemical composition of the adsorbents was determined by X-ray fluorescence. Batch adsorption experiments will be conducted to investigate the adsorption of Zn (II), Cd (II), and As (V) by the natural manganese oxides. The adsorption characteristics will be determined for the abovementioned cations at acidic pH i.e. 2, 4, 6 in an aqueous solution, and testing two different initial concentrations for each of the metals Zn, Cd, and As. The final solutions will be analyzed by flame atomic absorption spectrometry (F-AAS) and by inductively coupled plasma mass spectroscopy (ICP-MS).

**Conclusion**: By conducting these experiments the adsorption potential of the natural manganese oxide towards the removal of heavy metals will be evaluated to investigate the usage of these natural minerals as more economic and efficient adsorbents of common pollutants from natural waters and waste waters.

S1-PP10

# Preliminary assessment of nitrate sources of pollution in the urbanized catchment of the Kifissos River

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Nitrate ($NO_3$) is considered a contaminant of concern because its presence within the environment is linked to various environmental and health effects (McIsaac et al., 2001; Shearer et al., 1972). Such concerns have led to legislations aiming at limiting nitrate concentrations in aquatic systems (e.g., Water Framework Directive (WFD) 2000/60/EC).
The Kifissos River is an urban river that belongs in an urbanized catchment (Kifissos River Basin-KRB) in the western part of Athens metropolitan area (~3.8 million inhabitants). The river is ~25 km long and discharges into the Saronikos Gulf, close to Piraeus port. Most of the year river water discharge is low (~3.2 $m^3/s$), but during flood events the water fluxes may reach up to 1,400 $m^3/s$ (Zeri et al., 2021).
A systematic collection of water samples from 5 monitoring sites in the KRB was done from April 2021 until October 2022 on a monthly basis. The water samples were analyzed for N-species using an Ion Analyzer (Metrohm) at the HCMR laboratories and were complemented with in-situ measurements (e.g., pH, Electrical Conductivity, Dissolved Oxygen (DO)) using YSI instruments.
The preliminary results showed that the overall nitrate-nitrogen concentrations ranged between 1.7 and 18.7 mg/l (average: 7.6 mg/l, as $NO_3$-N), whereas ammonium-nitrogen concentrations were between 0.01 and 2.38 mg/l (average: 0.26 mg/l, as $NH_4$-N). The nitrate-nitrogen concentration values (as $NO_3$-N) increased from upstream (Kif_MD average: 6.2 mg/l) to downstream peaking high at Podoniftis tributary (average: 9.5 mg/l) but decreased at the main river outlet (average: 7.4 mg/l) due to seawater influence. Most river sites exhibited their highest N-concentrations during summer season when discharge was lower. Our survey showed that according to the WFD standards, the quality for nitrates is bad, while for ammonium varies from moderate to bad. Therefore, the KRB undergoes nitrate pollution, which originates mainly from urban runoff, wastewater and industrial effluent discharges and on-site sanitation systems.
The current work was conducted under the F32010 project and funded by the International Atomic Energy Agency.

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S1-PP11

# Polycyclic aromatic hydrocarbons in road deposited sediments from Athens and flood depositional sediments from Mandra, Greece: Spatial and seasonal distribution, and potential toxicity

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Urban areas are reflective of a wide range of anthropogenic activities and industrial areas within the urban net are commonly recognized as contributors of different types of pollutants. Road deposited sediments (RDS) are the main receivers of contaminants delivered by stormwater within an urban area and provide good indication of the level of contamination by polycyclic aromatic hydrocarbons (PAHs) (Nawrot et al., 2022). This study probed the spatial and seasonal pattern, sources and related toxicity potential of PAHs for human health, at four sampling sites in Athens during one year and four sampling sites in the industrial area of Mandra town for one year, following the occurrence of a flash flood event. The total PAH concentrations ranged from 451 to 4940 ng/g in RDS from Athens and from to 509 to 6144 ng/g in the Mandra samples, respectively. PAHs were dominated by relatively high molecular weight compounds indicating that high temperature combustion processes were the predominant source. Diagnostic ratios demonstrated that the primary source of PAHs in RDS was pyrogenic processes, i.e., combustion of petroleum, gasoline vehicle exhausts, coal and wood combustion. Seasonal variation results showed that PAH concentrations did not follow a particular pattern, with the exception of one sampling site in the industrial area of Mandra where the concentrations of PAHs were persisting for two subsequent sampling periods, thus indicating the presence of a single point source of contamination. The potential toxicity of PAHs calculated using the Toxicity Equivalent Quotient -Benzo(a)pyrene toxic equivalent quantity (TEQBaP) has an estimated average value of 71.1 ng/g in Athens samples and of 135 ng/g in Mandra samples. These values, especially for the Athens samples, are comparable with those observed in Campania (Thriombane et al., 2019) and Tarragona (Nadal et al., 2007) urban areas of south Europe.

**Acknowledgments:**
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S1-PP12

# Geochemistry of metal(loids) in soil and river sediment along the Asopos river basin, Greece

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In recent decades, industries and factories have been increased in Greece to meet the modern needs of the society. As the development continues, the environmental status of the area has been degraded, which is related to industrial discharges of wastes nearby rivers and seas. A resembling environmental problem has been located at the Asopos river basin mainly around the industrial zone of Oinofyta (Panagopoulos et al., 2015; Lilli et al., 2015). The Asopos river, a total length of ~57 kilometers, is passing across Sykamino, Oropos, Schimatari and Oinofyta and discharges into Evoikos Gulf. A total number of 13 surface river sediment samples and 13 soil (0-20 cm depth) samples were collected along the river course, from the upstream of Thiva to the downstream of Oropos. The soil samples were collected in the immediate vicinity of the samples from the river bed and were principally used for agricultural purposes. The sediment and soil samples were dried at a constant temperature of 50oC for 3 days in a thermostatically controlled oven. They were subsequently disaggregated in a porcelain mortar and sieved to <2 mm fraction. A portion of the -2mm fraction was pulverized and used for analytical determinations. The EPA method 3050B was applied to determine metal (loid) content in sediment and soil samples, followed by inductively coupled plasma mass spectrometry (ICP- MS). X-ray diffraction was used for mineralogical investigations aiming to examine variations in mineralogical composition according to geological background. Results of geochemical analyses have been interpreted in relation to the bedrock lithologies, land use patterns and anthropogenic pressures.

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S1-PP13

# Major and trace elements geochemistry of geothermal water from the Nappe Zone, northern Tunisia: Implications for health risk assessment and mineral prospecting

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Northern Tunisia has high geothermal potential due to its location on the Maghrebides fold-and-thrust belt. A comprehensive hydrogeochemical survey of the geothermal waters from the Nappe Zone, northern Tunisia, was undertaken. A total of 11 geothermal water and three surface water samples were collected and analysed for major (pH, EC, TDS, Na+, K+, Ca2+, Mg2+, HCO3−, Cl−, NO3−, and SO42−) and trace elements (As, B, Ba, Mn, Pb, Sb, Sr and Zn). This study aims to determine relationships between hydrochemical patterns and geological origins of geothermal waters and assess their health risks associated with potentially toxic elements.
Hydrogeochemical tools (i.e. Piper plot, Langelier-Ludwig diagram, ionic ratios and Na-K-Mg1/2 triangular diagram) propose the presence of two main geothermal water groups (G1 and G2). G1 samples are Na−Cl type with total dissolved solids (TDS) above 2 g/l and have the highest average contents of Cl−, Na+, SO42−, Ca2+ and Mg2+. The G2 samples have TDS below 2 g/l and are Na-Cl-HCO3 type. Most of the geothermal waters are categorised by a molar Na+/Cl− ratio close to 1, indicating that the dissolution of evaporitic formations rich in halite is the source of dissolved Na+ and Cl−. A curved hydrogeochemical evolution path is observed from mixed Ca(Mg)−Cl meteoric waters to Na−Cl geothermal waters, indicating that water-rock interaction and mixing processes can drive the chemistry of the geothermal samples.
The principal component analysis (PCA) shows four main hydrogeochemical associations related to lithologic, tectonic, water-rock interaction and anthropogenic sources. The first association (PC1) is formed by TDS, EC, Cl−, Na+, SO42−, Mg2+, Ca2+, and As, which we associated with deep fluid circulation. The second association (PC2) formed by HCO3−, Pb, Zn, Ba, and Mn might be interpreted as mixing processes with shallow groundwater (or seawater). The third association (PC3) formed by Sb and Sr could be related to water-rock interaction. The association 4 (PC4) formed by NO3− could be controlled by agricultural practices.
The health risk assessment reveals that the concentration of potentially toxic elements in geothermal waters is lower than the guideline values for protecting freshwater aquatic life. In addition, health complications of dermal exposure (via bathing or balneology) are within safe limits.

S2-PP14

# Arsenic chemical form and bioaccessibility and its health risk in the calcareous soil contaminated by nonferrous metal smelting

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Arsenic is both toxic and carcinogenic. Arsenic contamination of soil may result from mining, milling, and smelting of nonferrous ores. Arsenic in soil can directly enter human body via ingestion, dermal absorption, and inhalation and thus leads to health risks. We examined arsenic contamination and its health risk in the calcareous soil in a nonferrous smelting area. Topsoil and soil cores were collected and analyzed for arsenic chemical forms and bioaccessible forms employing selectively sequential extraction method and physiologically based extraction (PBET) method, respectively. Arsenic in the soil ranged from 10.3 to 153.9 mg/kg, which were mainly associated with soil carbonate, iron/manganese oxides, and organic matter. Bioaccessible arsenic concentrations in the gastric and intestinal phases of the calcareous soil ranged 0.23 to 41.2 mg/kg and 0.46 to 35.7 mg/kg, respectively. In addition, arsenic concentrations in each chemical and bioaccessible form were significantly correlated with total arsenic concentration in the soil. Arsenic enrichment factor in the soil ranged from 1.2 to 16.9, with an average of 5.8. This showed that the soil was contaminated seriously by arsenic. Average hazardous quotients for children via soil ingestion were 2.12, 0.45, and 0.34 based on total, gastric bioaccessible, and intestinal bioaccessible arsenic concentrations, respectively. Average hazardous quotients for children via dermal absorption and inhalation were 0.12 and 0.002, respectively. Average carcinogenic risks via soil ingestion were 1.16×10-4, 2.46×10-5, and 1.88×10-5 based on total, gastric bioaccessible, and intestinal bioaccessible arsenic concentrations, respectively. Average carcinogenic risks via dermal absorption and inhalation were 9.07×10-6 and 5.65×10-8, respectively. Therefore, arsenic contamination in the soil by nonferrous smelting would pose health risk to residents mainly via soil ingestion.

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S2-PP15

# Geochemical enrichment of thallium and related human health risks in soils with high geological background in the karst region, Southwestern China

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The high levels of thallium (Tl) contamination in the environment and associated health risks in southwestern China have gained significant attention. This study aimed to evaluate the geochemical enrichment characteristics and potential health hazards of Tl in soils from a high geological background area in southwestern China. The findings revealed that Tl was highly enriched in surface soils, with enrichment factor (EF) values ranging from 0.79 to 63.33, indicating secondary enrichment during the natural pedogenesis of local Tl-bearing carbonate rocks. The significant accumulation of Tl in soils posed high ecological risks for most sampling sites (63.3%). The mean hazard index of Tl in the high geological area exceeded the safe limit, posing a threat to the local public's health. Moreover, non-carcinogenic and carcinogenic risks to children were higher than those for adults. Based on the health assessment model, the hazard quotient levels for different Tl exposure pathways were ranked in the order of ingestion > dermal contact > air inhalation. Results of the simplified bioaccessibility extraction test (SBET) and physiologically based extraction test (PBET) indicated that Tl bioaccessibility was relatively higher in the gastric environment than in the intestinal environment. Thallium was identified as the major element of concern, contributing the most to the overall health risk to local residents through soil ingestion. Therefore, this study provides fundamental data for identifying environmental risks and offers rational guidelines for future Tl contamination regulation and management in soils.

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S2-PP16

# Laboratory methods for the extraction and characterization of microplastics in sediment and soil samples of the Attica region in Greece

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Empirical research involving method development and appropriate quality control procedures is of paramount importance for reaching the ultimate aim of assessing the risk of microplastics in different environmental compartments. Particularly, for sediments and soil, several challenges exist including enclosure of microplastics in soil aggregates and similar density (ρ = 1−1.4 g cm−3) of soil organic matter to most plastics, impeding separation. Also, the natural weathering of plastic particles is a factor that should be considered. A spiking experiment took place by dosing grained (<2mm) soil samples with polyvinyl chloride (PVC), polypropylene (PP) and polyethylene (PE) polymer particles (<2mm) in two forms: a) Not exposed to any weathering process polymers and b) Oxidised polymers by hydrogen peroxide H2O2 (30%) solution. Extraction techniques for both forms were applied, such as a density separation step, using saturated NaCl solution (Quinn et al., 2016) and H2O2 (30%) solution (Li et al., 2019), for the removal of organic matter. Freshly cut polymer particles as well as recovered polymer particles were studied with a stereoscope to estimate the recovery rate of the method and observe the degradation between different types of polymers. This adjusted method will be applied to additional soil samples from a systematically collected soil dataset of Attica region in Greece, representing differ ent land use types, i.e natural and agricultural for comparison. If the recovery is not satisfactory, a different adjustment method will be used. To reach specific conclusions on which polymers will be retrieved and to what extent they have been corroded, analysis by Raman spectroscopy and Fourier-transform infrared (FTIR) spectroscopy will be used.

S2-PP17

# Forest fires effect on groundwater quality and soil properties: The case of northern Euboea, Greece

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The devastating forest fires that hit northern Euboea Island, Greece, in August 2021, destroyed more than 50910ha according to the data of the Rapid mapping module of the Copernicus Emergency Management Service. Many physical and chemical soils properties may be affected by forest fires. Generally, in post-fire runoffs, nutrients and particulate matter transportation generates a potential risk to soil-water-biota.
The main geological formations outcropping in the area studied are peridotite bodies and volcanic rocks, covered by extensive Neogene deposits. The fire-affected area is characterized by abrupt slopes, downcutting erosion and a dense drainage system. According to CORINE (CLC, 2018), almost all the affected area was covered by coniferous and broad-leaved forests.
Forty ground water samples were collected during late dry and wet season from wells and pipes used for water abstraction, covering most of the area affected by wildfire. Furthermore, 30 top- and subsoils were collected from burned areas. Physical and chemical sensitive parameters of water were measured in the field. Samples were analyzed for anions ($NO_3^-$,$SO_4^{2-}$,$PO_4^{3-}$ and $Cl^-$) and trace elements (Cr,Mn,Fe,Co,Ni,Cu,Zn,As,Rb,Sr,Cd,Al,V,Cs,Ba,Tl,Pb) in the acidified portion of the samples. Soil samples were analyzed for pH and TOC. After digestion with aqua regia Pb,Zn,Cd,Cu,Mn,Fe,Cr,Ni,Co "pseudo-total" contents were determined by F-AAS. Aiming to evaluate leaching levels of potentially toxic elements from soils and understand the impact of environmental conditions a series of natural rain-surface and mineral water leaching experiments were carried out. The leachates were analyzed for Cu,Pb,Ni,Cd,Cr,Mn,Zn by ICP-MS.
Trace elements and anions measured in groundwater samples were determined in concentrations below the EU regulations. The comparison of anions values between the two sampling periods revealed a regression of nitrates and chlorides and an increase of sulphates and phosphates. The values of pH and most trace elements exhibited a decreasing tendency ten months after wildfire. Soil samples exhibited elevated median values compared to those in adjacent unburned areas (Megremi, 2010) but comparable to those in burned areas with similar geological formations. Correlations coefficient between elements in both affected and unaffected soils implies their geogenic origin mainly associated with the ultramafic rocks and related ores of the study area. Soil pH values indicated neutral to alkaline conditions, while TOC exhibited higher values in topsoils than subsoils. Element concentrations in soil leachates were significantly lower than their "pseudo-total" contents with no correlation between them. The reducing order of elements leachability in soil leachates does not coincide with the identified decreasing order of elements "pseudo-total" median values in soils. Further research is carried out to identify the existence of PAHs in the burned areas and for the determination of elements speciation both in burned and unburned areas.

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S2-PP18

# Aluminosilicate treatments to remove an anionic azo dye from textile wastewaters and organic wastes

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Organic wastes typically contain large amounts of disposed textile [Biyada et al., 2021] and leather [Miranda et al., 2019] dyed products and, also, synthetic azo dyes used in cosmetics, pharmaceuticals and soaps. These dyestuffs, toxic and persistent pollutants, must be removed from the organic waste prior to its composting and subsequent commercial application in sustainable agriculture. During composting, water-soluble synthetic dyes migrate from the organic phase to an aqueous environment. On the other hand, substances present in textile dyeing and finishing processes, i.e., dyes from various classes, are lost in dye wastewaters and conventional wash-off procedures.

Organic azo dyes should be retained on a water-insoluble material, e.g., an adsorbing substrate, by other than merely mechanical retention [Roulia and Vassiliadis, 2008; Roulia and Vassiliadis, 2005] to obtain a quality compost. When synthetic colorants, most commonly associated with aromatic ring systems, must be removed from textile dyeing effluents, adsorption is an economically attractive technique and perlites are useful, abundant, environmentally friendly adsorbents [Roulia and Vassiliadis, 2008; Roulia and Vassiliadis, 2005]. Thus, decolorized wastewaters are widely used in semi-arid regions as irrigation water for agriculture in order to overcome water shortage.

C.I. Acid Black 1 (AB 1), an anionic colorant, is suitable for dyeing animal fibers, leather, cellulosics, anodized aluminum, organic substrates, hair, drugs, personal care products and proteins. The adsorption of C.I. Acid Black 1 from an aqueous solution on perlites, i.e., raw and expanded, was employed to study the adsorptive effectiveness of these aluminosilicate materials on dye removal from organic wastes. A number of widely accepted theoretical adsorption models were applied to reveal essential physicochemical features of the adsorption and to describe the relationship between the organic dye and the edge-sites on aluminosilicate matrix [Roulia et al., 2014].

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S3-PP19

# Element dilution factors for detecting trace metal contamination along an AMD (Acid Mine Drainage)-affected stream

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**Introduction**: AMD (acid mine drainage) -related trace metal contamination remains a significant environmental problem worldwide. Secondary oxides and oxyhydroxides of Fe and Al are known to concentrate trace metals in sediments because of their high specific surface areas and high cation exchange capacities.

**Methods:** Stream water and overbank sediment samples were collected at six locations along a section of the Blesbokspruit River at Emalahleni, South Africa, to investigate the potential of calculated Fe and Al 'dilution factors' (stream water divided by overbank sediment concentrations) to detect AMD-related trace metal contamination in the study site under base flow hydrological conditions.

**Results:** Fe and Al dilution factors showed moderate to strong positive correlations with dissolved trace metals (Co, Ni, Zn, Pb, Cr and Cd), but not with Cu, which is likely more associated with kaolinite in the study area. Based on median +/- MAD (median absolute deviation) concentrations, sample locations can be categorized according to Fe dilution factors into classes of low (< 0.001023), moderate (0.001023 – 0.001307) and high (> 0.001307) trace metal contamination; and according to Al dilution factors, into classes of low (< 0.000527), moderate (0.000527 – 0.001324) and high (> 0.001324) contamination.

**Conclusions:** Results suggest that Fe and Al dilution factors are potential proxies for detecting AMD-related trace metal contamination in streams under base flow conditions and thus, may be useful for monitoring AMD-related contaminants during dry seasons. The advantages of using Fe and Al to detect AMD-related trace metal contamination in streams, are that (i) they are major elements in AMD-contaminated environments and thus, can be analyzed with greater precision than trace metals, and (ii) they would require the analysis of dissolved and sediment concentrations of only two elements (i.e., Fe and Al), as opposed to several AMD-related trace metals, thus, potentially and significantly reducing the cost and time of laboratory analysis.

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S3-PP20

# Coupled geochemical data and unmanned aerial vehicle imaging of mining waste in the Sounion National Park

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Intense mining activity both during ancient times and during the 19th and 20th centuries in the area of Lavreotiki resulted in extensive piles of mining waste that remain exposed until today. The mining and metallurgical processing of massive Pb-Zn-Ag marble replacement sulfide ore as well as its supergene alteration calamine ore, caused significant impact on the environment of Lavreotiki Peninsula. In areas heavily contaminated by metal(loid)s, the vegetation is usually sparse, its composition changes, plant vitality decreases, and morphological variations are observed in some plant species. Nevertheless, with time, many native plant species manage to develop suitable contamination resistance mechanisms.
In this context, the objectives of this study are: i) the visual mapping, using an unmanned aerial vehicle, of specific mining waste piles within the Sounion National Forest and the visualization of the relationship with the surrounding vegetation, ii) the study of seasonal changes on the boundary between waste piles and vegetation in relation to changing meteorological parameters, and iii) the investigation of relationships between the visual observations and the physicochemical characteristics of the waste piles. Aerial images (photos and videos) were taken repeatedly in six visits to the area between October 2020 and December 2022 in order to capture the seasonal change of vegetation. The processing and evaluation of the visual material was carried out using appropriate software in order to visualize the study areas in 3D. Subsequently, the results were discussed based on the description of the physicochemical characteristics of the piles as derived from previous studies.
The results include detailed aerial mapping of the mining waste piles and the production of video to better understand the interaction between vegetation and the mining waste over the course of the year. This work contributes to a detailed recording and environmental assessment of the piles of mining waste in the areas of Kamariza and Sounion in Lavreotiki, which will form a usable database for the management and protection of the Sounion National Forest.

S3-PP21

# Urinary hydration correction for trace elements influencing child and maternal health status in western Kenya

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Maternal micronutrient requirements during pregnancy increase to meet the physiologic changes in gestation and foetal demands for growth and development. The incidence of maternal micronutrient deficiencies is elevated in western Kenya and co-exist in many settings, likely influencing birth and new-born outcomes. The nutrition of pregnant mothers and infants is offered measured using a range of bio-matrices either to measure representative micronutrient status defined by established guideline values or by physiological biomarkers e.g. enzyme, hormones. This dataset concerns the measurement of micronutrients in urine, using a popular non-invasive biomarker of micronutrient status. However, data is commonly used and published without considering the hydration status of the volunteer, which could inhibit the effectiveness of urinary elemental concentration data to inform intervention strategies.

This pilot study set out to investigate micronutrient status in mother-child paired samples from 70 households in Uasin Gishu County in western Kenya. Data will be reported for this small group and evaluate the mother-child relationship for micronutrient status and present data incorporating the hydration correction of urine elemental corrections using three methods: creatinine, osmolality, and specific gravity. Data is presented via statistical analyses to suggest appropriate correction methods for specific trace elements, in comparison with uncorrected elemental concentrations. For example, creatinine was shown to have a poor correction for urinary iodine concentrations, with osmolality providing more reliable outcomes. Osmolality was most effective for zinc and creatinine for selenium.

This dataset builds on previous research to promote the need for bespoke hydration corrections according to specific trace elements. This is particularly important when determining health status according to guideline concentrations, against which interventions for deficiency or excess of supply in the diet may be incorrectly informed. This approach is particularly important in a developing world scenario where protein intake may vary considerably and in hot environments/livelihoods with a high degree of activity resulting in large changes in hydration, both of which may influence the proxy measurement for micronutrient status.

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S3-PP22

# Roadside pollution screening using magnetic properties of urban road dusts from the broader area of the city of Thessaloniki: Particle size effect and spatial distribution

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Roadside dust is undoubtedly among the most common sources of environmental pollution in urban areas. The applicability of magnetic monitoring has increasingly been applied for the evaluation of anthropogenic pollution with magnetic susceptibility being the most commonly used tool to map and monitor pollution load of multiple environmental media including road dusts. In this study, magnetic measurements were tested as a proxy to screen the degree of roadside pollution in the city of Thessaloniki, the second largest city of Greece. A total of 54 representative sites were selected (24 from west suburbs-THD, 15 from east suburbs-THA and 15 from city center-THC), where composite samples were collected by sweeping an area of 1m². Particle size effect on magnetic signal was evaluated on two different size fractions, <500μm and <250μm. The mass specific magnetic susceptibility (χlf) values were ranged from 70 to 930 × $10^{-8}$ $m^3$/kg (mean 303 × $10^{-8}$ $m^3$ / kg) for the <500μm size fraction, while higher values were recorded in finer fractions (<250μm) with a range of 93-1253× $10^{-8}$ $m^3$ / kg (mean 371× $10^{-8}$ $m^3$/kg). Spatially, χlf values presented a trend of THD > THC > THA for both size fractions. Thus, significantly higher values were recorded in the western part of the city (THD) with means of 341× $10^{-8}$ $m^3$/kg and 424× $10^{-8}$ $m^3$/kg for the <500μm and <250μm size fractions, respectively. Contour maps produced indicating that the highest values of magnetic susceptibility were narrowly concentrated to high traffic areas. The mean χfd values were 1.17 % and 1.34 % for <500μm and <250μm size fractions, respectively, indicating the absence of superparamagnetic (SP) grains which is characteristic of roadside environments. Finally, an increase of the magnetic signal over the years was revealed since the obtained χlf values were higher than those reported for 2014.

S3-PP23

# Triethylamine-assisted Mg $(OH)_2$ coprecipitation/preconcentration for determination of trace element concentrations in rainwater from Sicily, Italy

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Studies on trace elements composition of rainwater are an emerging tool for environmental monitoring of pollution of the atmosphere, soils, and water resources. A magnesium hydroxide ($Mg(OH)_2$) coprecipitation method for the determination of 17 trace elements (Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Mo, Cd, Sn, Sb, Te, Pb, U) in rainwater samples was applied. Rainwater samples were collected through bulk collectors, from March 2021 to November 2021, at 15 sampling sites located in different contexts and divided into two 50 mL aliquots. The first was filtered (0.45 µm) and acidified with ultrapure $HNO_3$. The second one was filtered with the same filters and then enriched adding 500 µL of $MgCl_2x6H_2O$ and subsequently 200 µL of Triethylamine (an alkylamine, weak base) to the solution; this procedure triggers the precipitation of $Mg(OH)_2$ scavenging a large suite of trace elements from the rainwater. The solutions were centrifuged at 6000 rpm for 20 minutes, the supernatant was discarded, and the precipitate was dissolved first in 1.5 mL of 7% $HNO_3$, and then in 3.0 mL of 1% $HNO_3$. Both aliquots were analysed with ICP-MS (Agilent 7800ce). In the co-precipitated aliquot, fewer samples resulted below the detection limit, especially for Cd (0.18%), Sn (61%), Te (42%), Pb (22%), and U (18%). Important differences in the concentrations (on a median basis) of trace elements were observed between the two aliquots, up to +233% for Pb (0.058 µg/L and 0.135 µg/L for the first and the second aliquot, respectively). For Te, Sn, Co, U, and Cu the recovery by co-precipitation was partial, up to -62% for Te. The magnesium hydroxide coprecipitation method can therefore be a valuable enrichment tool for better determination of trace elements' concentration in highly diluted matrices such as rainwater.

S3-PP24

# Analysis of premature deaths associated with particulate pollution in a lime industries area using low-cost air sensor data

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Lime is among the most consumed mineral products in the world, can be used in numerous industrial, environmental and chemical processes. However, in the lime production industry, the emission of particulate matter can be detected at essentially all stages of manufacturing and during the end product's storage. Extended exposure to elevated concentrations of lime dust can also generate lung damage, such as pneumoconiosis. Scientific studies have extensively investigated the contribution of gaseous emissions from lime production, however, there is little research on the effects of particulate emissions on the population's health. In the southern region of Brazil, the city of Colombo is a major producer of dolomite lime, although there are presently no official monitoring sites for PM2.5 in the area. In the present study, we analyzed an alternative for PM2.5 monitoring using low-cost air sensor and examined of the correlation between particulate pollution and premature deaths. The Harvard impactor was used to gather PM2.5 to investigate the chemical constitution of the particulate matter. Subsequently, X-ray fluorescence (XRF) was employed to identify the chemicals present. Daily PM2.5 levels were collected using a PurpleAir sensor, and mortality for all causes was obtained from Brazil's health system from April to December 2021. The average annual PM2.5 mass concentration during the study period 7,2 □g.m-3 was obtained by the sensors. This study revealed that long-term reduction of the average annual PM2.5 concentration in Colombo to below the WHO recommendation of 5 □g.m-3 could have avoided 2% of non-accidental deaths. Based on the XRF results, the Enrichment factor was calculated to identify the elements' anthropogenic source compared to the land. The analysis identified elements such as Ca, Mg, K, Mn, Cr, Ni, Cu, Zn, Cl, Pb, S, and Br in the particulate matter. According to the results, these elements originated mainly from anthropogenic sources, indicating that human activities are the primary contributors to the presence of these elements in the air. These elements' sources, especially Ca-Mg, could be attributed to the Lime production-processing. As conventional monitoring networks can be expensive and complex, our study demonstrates that low-cost air sensors can be a feasible option for public health applications in regions with potential pollution. Low-cost air sensors provide cost-effective and efficient monitoring of PM2.5 concentrations in both space and time. The application of operational control during lime processing can suppress the release of lime aerosol from this stage, thereby reducing potential risks to human health and the environment.

S3-PP25

# Assessment of railroad atmospheric emissions using UAVs

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UAVs technology presents a promising solution for detecting air pollution emissions using a “snif-fing” system. Among the multiple emissions sources, railroads can significantly impact air pollution through locomotive emissions. Monitoring these emissions is essential for understanding their impact on the environment and human health and developing strategies to reduce them. This research aims to evaluate the applicability of sensor-equipped drones in evaluating the concentrations of gaseous emissions from cargo and passenger trains over a railway located in Curitiba (Brazil), as such systems theretofore were not used in that kind of assessment. Accuracy of NO2, SO2, and O3 was appropriately accessed using reference equipment. Specifically, before the trains passed, the mean concentration of SO2 before was 20 g/m3, while the maximum concentration was 110 g/m3 during their transit. Meanwhile, the mean increase of NO2 concentrations was from 30 µg/m³ to 120 µg/m³; and for O3 concentrations, it was from 80 µg/m³ to 135 µg/m³. Prior to and after locomotives passed, vertical profiles were assessed at altitudes ranging from 1 to 15 meters above ground level. These profiles indicated an accumulation of pollutants over the railroad, hinting towards a positive correlation between the presence of a railroad and higher background concentrations of atmospheric pollutants. Out of the analysed gases, sulfur dioxide exhibited the most substantial increase, suggesting that the fuel used by trains in the city may contain high levels of sulfuric content. Additionally, the measured profiles revealed an accumulation of this particular species above the railway, which implies a positive association between the existence of a railway and elevated background levels of atmospheric pollutants. UAVs were used to reveal that the railway mode of transportation has the potential to produce harmful concentrations of gases that could negatively impact local air quality and public health.

S3-PP26

# Artificial neural networks assessed fire spot health impacts on the Manaus population

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Emissions from vegetation fires (mostly due to human intervention) are a global health, environmental, and ecological concern. Around 200,000 forest fires occur worldwide annually Deforestation rates in the Amazon rainforest is ever increasing, impacting Manaus, where reports of worsening citizen health is mainly ascribed to local transport and fire emissions an urgent need for effective measures to address the issue. To that end, health risks associated with air pollution need assessing, but prove to be challenging due to complex and nonlinear factors. Artificial intelligence algorithms (AIA) are increasingly used to provide more accurate health risk assessments which can inform the public health sector to intervene.

To create robust AIA models, more databases are needed. Cardiorespiratory hospital admissions, daily black carbon concentrations, number of fires, and meteorological variables (T, %RH, precipitation, and solar radiation) were collected for Manaus during October 2011 to August 2016. Four types of Artificial Neural Networks (ANN) were used as predictive modelling tools.

Of the three scenarios investigated (all inputs, excluding BC, excluding number of fires), the Multilayer Perception outperformed the other three models tested with the lowest Root Mean Square Error (RMSE). This could be ascribed to the ability of the fully trained MLP model to deal with incomplete data sets.

Overall, this study demonstrates the potential of artificial neural networks (ANN) as an effective method for assessing the health risks of air pollution, especially in regions prone to wildfires and where complete data sets are lacking. The results suggest that ANN may outperform traditional regression methods in predicting the health impacts of air pollution. This information can be useful for decision-makers in the health sector to inform public health interventions and policies in regions affected by air pollution.

S3-PP27

# Surface physicochemical and mineralogical characterization of coal ash and slag landfills (Croatia)

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**Introduction**
Coal combustion residues, in the form of ash or slag, constitute large amounts of material that needs to be disposed on annual basis. If not properly regulated, these disposal sites can become an environmental concern, causing pollution of the surrounding soil, water and biota. An important feature of these landfills, often overlooked, is their mineral composition. The alteration of physiochemical properties of inorganic surfaces with long-term exposure to environmental conditions can, through contaminant release and sequestration, determine the overall effect of these deposits on the surrounding environment. The aim of this study was to identify the mineral phases and their properties in order to gain insight on the stages of dry landfill evolution and the possibility of contaminant release into the environment.

**Methods**
The investigated locations are two unlined, aged, coal ash landfills in Croatia; Štrmac and Plaški. Samples of the landfill material and the surrounding soil were mineralogically characterized by X-ray diffraction, their particle size distribution (PSD) determined by laser granulometry, and surface physicochemical characterization included determination of cation exchange capacity (CEC) and specific surface area (SSA).

**Results**
The results showed presence of similar mineral phases, with different abundance, at both sites.
Differences in abundance of ettringite, gypsum and portlandite indicate different stages of the landfill evolution at these two sites. While kaolinite and illite were present at both sites, montmorillonite was determined only at the Plaški landfill, reflecting in the overall higher values of SSA and CEC in these samples.

**Conclusion**
Variations in the ratio of secondary minerals formed with ash exposure to atmospheric conditions indicate different stages in landfill evolution at these two locations. These variations were reflected in higher values of SSA and CEC at the Plaški landfill, and suggest its greater capacity to retain contaminants, preventing their leaching into the surrounding environment.

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S3-PP28

# Composition and reactivity of metals associated with wood ash to better understand the potential impacts on water quality

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Forest fires lead to a significant production of ash, either remaining in the soil (Oliveira-Filho et al., 2018) or carried through rainfall events towards aquatic ecosystems by surface runoff (Silva et al., 2015). According to several researchers, post-fire events combined with rainfalls, lead to ash and top-soil flows into aquatic systems, exerting a complex impact on water quality, including increase in water turbidity, pH and conductivity, while oxygen depletion, with diverse and adverse effects on aquatic biota (Bixby et al., 2015). Post fire runoff was pointed as responsible for the transport of organic matter and nutrients with debris and ash within aquatic systems such as lakes.

One of the massive forest fires that occurred in 2021 advanced up the slopes of Mount Parnitha, constituting a national park north of Athens metropolitan area and one of the last substantial forests remaining close to the Greek capital. The present study investigates the effect of this fire on the environmental characteristics of the surface waters of Marathon lake. For this purpose, water samples were obtained from the surface microlayer (SML) of the lake and ash leaching experiments were carried out in the laboratory. The analytical approach followed is multiparametric, aiming to obtaining information on the composition and reactivity of metals associated with wood ash, in order to contribute to a better understanding of the potential impacts on water quality and to assess the viability of current treatment methods.

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S3-PP29

# Changing the nutritional status of forage grass due to changing soil chemistry resulting from different land-use management in the Oroba Valley, Kenya

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Threats from land degradation may escalate problems of inadequate food supply and poverty that already afflict the inhabitants of Oroba valley, Nandi County in Kenya. The steepness of the farmlands along with inadequate application of sound agricultural management systems expose the area to soil erosion, loss of soil fertility, and salinization. Both crop and livestock agriculture face risks of soil degradation. Here, forage grass contributes to 60% of animal nutrients and this study investigated the micro-elemental levels of forage grass from four differently managed farms with different history of use. The grass was sampled from four differently managed plots in a randomized block design: plots 1 and 2 contained five sections(blocks), while plots 3 and 4 contained six sections. Grass samples were collected, and analysed for thirteen essential elements (Na, Mg, P, S, K, Ca, Cr, Mn, Fe, Cu, Zn, Se, Mo) by ICP-MS. The uptake of elements is influenced by soil pH as K(0.27), Cu(0.76), and Mo(1.17) were enhanced with a positive correlation between the levels of acidity in the soil and the concentration of elements in plants which indicated a negative to Mg, P, Ca, Fe, Zn, and Se. Soil Organic Matter contents also affects the element uptake by grass, with Mg and Zn only showing a positive correlation of 1.11 and 0.48, respectively. Land use management was the other factor that affected the nutrition status of forage mono-cropping. Continuous cultivation increases the possibility of soil erosion, indicating essential elements loss from the study area depicted by accumulation at the base of the study plots. Results from the study have shown that different land management affects the soil chemistry, hence changing grass's absorption regime for micronutrients. Cultivation agitates the mobility of essential elements, enriching the food chain with macro and micronutrients. Smart farming should check the issue of hidden hunger caused by land degradation.

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S3-PP30

# Fusing marine radioactivity mapping and geochemical data using state-of-the-art GIS technology

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The RAMONES project will investigate the connection between radioactivity and hydrothermal activity in the coastal zone of Paleochori in Milos Island in Greece, by correlating the radioactivity geospatial distribution with other geological and geochemical data (e.g. measurements of physicochemical parameters). In particular, a GIS framework will be developed to collect, store, manage, analyze, and visualize spatially distributed data. Within such a framework, geospatial data from both literature and from RAMONES project will be collected and homogenized to process them as input for the relational File Geodatabase (FGDB) integration. All data could be displayed as either vector data depicted as points, lines, or polygons or raster data, which represent geospatial information as a matrix of cells. The RAMONES FGDB data will produce spatial-temporal representation and visualization to generate thematic maps 2d and/or 3d scenes illustrated in a specific colour code related to the measured units/concentrations, concerning the level of interaction including such zoom level, initial scale of a map/scene. Furthermore, the GIS framework will be able to produce heat maps, by a five-colour code (no risk, normal, low risk, high risk, eminent risk), in an effort to inform the interested stakeholders. The main goal is to investigate natural radioactivity outflow pollution (e.g such as radon emissions) and how this can be correlated with geo-hazards and fault activity in the particular area.

S3-PP31

# Heavy metal concentration and characterization of magnetic particles in soils from Central Macedonia, N. Greece.

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**Introduction:** Soil contamination caused by natural processes or human activities can have hazardous effects on living beings as well as leading to degradation of soil making it no longer functional. The present study has been carried out to determine heavy metal concentration of soil samples from Central Macedonia, N. Greece. Studies have shown that heavy metals are linked to magnetic particles ((Hu et al. 2007, Jordanova et al. 2003) and therefore morphological and chemical characteristics of the magnetic particles extracted from the soils were also investigated.

**Methods:** Forty-one soil samples were collected from different areas of Northern Greece. All samples were dried and sieved (<150μm) and analyzed for 9 major elements with X-ray fluorescence (XRF). A subsample of 22 was measured with inductively coupled plasma mass spectrometry (ICP-MS) for 10 trace elements, by the aqua regia method according to ISO 11466. Magnetic particles were extracted by using a hand magnet and examined with scanning electron microscopy (SEM) coupled with an energy dispersive spectrometer (EDS).

**Results:** Chemical analyses of the samples were processed with multivariate statistical analysis. Pearson correlation coefficients and the contamination factors CF, as proposed by Hakanson (1980), were calculated using the average soil analysis proposed by Kabata Pendias (2011). Positive correlation between Cr, Co, and Ni, as well as between Ba and Zn, and Pb and Ni was observed. High values of CF (>6) were calculated for Pb, Cr, Ni and As.

**Conclusions:** The geological formations of the study area vary including ultramafic rocks, sedimentary rocks as well as metamorphic rocks. The high values of CF were mapped and compared to the geology of the study area. The high values of Cr, Co and Ni are associated to ultramafic rocks while As is associated to geothermal fluids indicating natural sources. High values of Pb in certain areas is probably associated with human activities such as agriculture and fuel combustion. SEM-EDS revealed the presence of angular and crystal shaped magnetic Fe-rich particles pointing to lithogenic origin.

S3-PP32

# Bioaccessibility: Estimation of Pollution status of Enyigba, Abakaliki mine district of Southeast Nigeria using indicator variables obtained from the sequentially extracted bioaccesible heavy metals in the soil of the area.

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Bioaccessibility can be explained as the proportion of target material available for absorption and incorporation into the biota which is essential for every contamination and pollution studies. Select heavy metals at Enyigba town in Abakaliki mine district were evaluated using indicator variables obtained from readily accessible metals in soil. A total of 25 soil samples and 10 plant sample were obtained from the mine sites and the adjourning farmlands respectively. Sequential extraction digestion was used to obtain the readily accessible metals (the exchangeable and the reducible) whereas the aqua regia digestion was carried out on plants. The result of the analysis showed the mean values of bioaccessible heavy metals at the Enyigba town are as follows: Cu=1.84mg/kg, Zn=0.97mg/kg, Fe=167.95mg/kg, Pb=110.85mg/kg and Cd=1.78mg/kg whereas the values of reducible fractions are Cu=.334mg/kg, Zn=21.1404mg/kg, Fe=1066.559mg/kg, Pb=57.653mg/kg and Cd=0.316mg/kg. Also, the average values of metals in cassava and rice plant are Cu=8.49mg/kg, Zn=35.134mg/kg, Fe=96.59mg/kg, Pb=8.887mg/kg, Cd=3.705 and Cu=2.383mg/kg, Zn=8.388mg/kg, Fe=103.58mg/kg, Pb=4.8mg/kg, Cd=1.338mg/kg respectively. The statistical analysis revealed that the value of Cu and Zn in plants are beyond the readily accessible fraction whereas the value of Pb and Cd in the plant falls within the readily accessible fraction in the soil but are beyond the allowable limit of edible plant. The Geoaccumulation Index of the Fe, Pb and Cd are moderately to heavily contaminated/polluted whereas Cu and Zn are uncontaminated to moderately contaminated. Therefore the above data shows that bioaccessible Pb and Cd have high contribution to the pollution index and measures ought to be put in place to forestall further pollution and possible remediation in order to avert both Pb and Cd poisoning.

S3-PP33

# Raman Spectroscopy: New research opportunities in Economic Geology and Environmental Geochemistry in the National and Kapodistrian University of Athens (N.K.U.A)

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Raman Spectroscopy is a non-destructive chemical analysis technique in modern mineralogy, which provides detailed information about chemical structure, qualitative phase identification and/or quantitative phase characterization, polymorphism, and crystallinity (Nasdala and Schmidt, 2020). Raman spectroscopy has crucial importance in genetic models of hydrothermal ore deposits, by providing data on the complexation and speciation, solubility, and fluid–melt partitioning of certain metal(loids) and thus identify important reactions that lead to ore mineral precipitation (e.g., Schmidt, 2018). Equally important in Economic Geology is the application of Raman spectroscopy analysis of carbonaceous materials, which is strongly associated with sediment-hosted orogenic or Carlin-type gold deposits (e.g., Hu et al., 2017; Wu et al., 2018), and analysis of fluid and melt inclusions that has significantly advanced our understanding of the nature of fluids in the deep crust and upper mantle (Bodnar and Frezzotti, 2020). In Environmental Sciences, Raman spectroscopy is used for the identification of pollutants and contaminants in soil, and the characterization of nanoparticles, providing insight for their transport and bioavailability (Das and Hendry, 2011). The Laboratory of Economic Geology and Geochemistry utilizes Raman spectroscopy available in the newly established Core Analytical Facility of the School of Sciences, N.K.U.A., to address specific scientific issues in ongoing research of faculty members. Projects in Economic Geology include metallogeny of actively forming seafloor massive sulfide deposits in the Aegean Kolumbo submarine arc volcano; particularly, we examine the mineralogy, geochemistry and geomicrobiology of stibnite and orpiment ores associated with barite and apply Raman Spectroscopy to identify carbonaceous matter to decipher biogenic origin of Au-rich orpiment filaments. In addition, Raman spectroscopy is being used for the identification of ore phases from the Mn-Fe-Cu mineralization in Lavrion ancient mining district, Attica. The Laboratory aims to create a digital database for optical properties and Raman spectra of ore minerals. For that purpose, mineral collections of the Laboratory are catalogued and analyzed by Raman spectroscopy. This digital database will comprise an ore mineral atlas that will be available to all students of the Department. Environmental applications of this technique include the identification of different polymers in microplastics from soil samples and the characterization of spectral features, indicative of specific chemical treatment. Furthermore, Raman spectroscopy coupled with chemical analyses data has been used in the characterization of speleothems, providing insights on their interaction with the environment. In conclusion, Raman spectroscopy is a versatile and powerful analytical technique that has numerous applications in Economic Geology and Environmental Science. It can provide valuable information which can help inform decision-making in mineral exploration, mining, and environmental remediation.

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S3-PP34

# Hydrogeochemical evaluation of Cr (VI) groundwater contamination in an industrial area of Greece- Evidence from water analysis and suspended particles observations

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Groundwater contaminated with hexavalent chromium Cr(VI) is a worldwide problem of significant public health importance. In Greece, a special regulatory act (No. 100079/2015) has been enacted for the Assopos River basin, in Central Greece, where the largest industrial zone of Central Greece is located, covering approximately 15 km² with over 200 industrial units. The rapid industrial development of the area in the 1970's has caused extensive groundwater contamination by hexavalent chromium for decades (Dermatas et al., 2017). This study presents data collected from 2 groundwater monitoring wells during the wet and dry seasons of 2017 and 2018. The collected samples were analysed for major and trace elements by a variety of methods. Furthermore, SEM analysis was performed to identify and analyse particles on the suspension filters (<0.45 μm) using a JEOL JSM5600 microscope equipped with an energy dispersive spectrometer (EDS) (Oxford ISIS 300). The hydrochemical analysis results show that the groundwater chemistry is dominated by $HCO_3$- and Cl- in the anionic chemistry and $Mg^{2}$+ and $Ca^{2}$+ in the cationic chemistry, while Ca-Mg-$HCO_3$ and Ca-Mg-Cl-$SO_4$ are the main water types of the samples. A wide variability in hexavalent chromium concentrations ranging from 3 μg/l to 14,000 μg/l has been observed in the area, while measured concentrations during this study exceeded 1,000μg/l in both wells and all sampling periods. The evaluation of the Cr(VI) concentration levels has been related to industrial activity, and has been assessed by geochemical modelling of aqueous solutions. Hexavalent chromium concentrations were highly correlated to Cl- in all collected samples (R-sq = 0.978). Additionally, suspended particles rich in metal phases have been identified through the SEM study pointing to specific anthropogenic sources of Cr(VI) in groundwater.

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S3-PP35

# Evaluation of a rapid non-destructive method to determine PHE levels in living green wall leaves

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**Introduction:** The UK has increased investment in Nature Based Solutions to tackle an array of environmental issues, in particular using living green walls (LGW) to help improve local air quality as they act as a filter when polluted air passes through the foliage. Finding a relatively low-cost way of providing chemical analysis of LGW plant foliage could enable new ways of wide scale biomonitoring of air quality in the urban environment. We compared the method of X-ray Fluorescence Spectroscopy (XRF) against Inductively Coupled Plasma- Optical Emission Spectroscopy (ICP-OES), and Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) methods to assess if this was a viable option.

**Methods:** Plants were grown on IWANTPLANTS, Hyvert living walls and trimmed once a month for 6 months. The leaves of 8 varieties (Asplenium.s, Dryopteris.f, Hedera.h, Helleborous.f, Pachysandra.t, Leucothoe.z, Euonymus.k and Euonymus.f) were analysed for the elemental profiles, specifically potentially harmful elements (PHE), using the above-mentioned methods. XRF samples were dried and analysed as a powder, while the ICP samples were acid digested and therefore provide acid-soluble elements. For quality control purposes, a strawberry leave certified reference material (CRM) has been used and percentage recovery using the specific method was compared.

**Results:** The CRM recovery varied from 75% (Cr) to 118 % (As) for the XRF method. In general, the ICP methods underestimated the true value, but that could be ascribed to the sample preparation method which only provides acid soluble components. This implied that recovery as low as 50 % was recorded for Al in contrast to 88% for Mn. Al, Cu, Fe, Mn, and Zn levels in the leaves from the different varieties (8 varieties were tested) analysed, could be confidently identified (above the LoD) by XRF methods. For ICP-OES all elements could be identified, with levels above the LoD, except V. The elemental profiles of the leaves varied significantly, even though the biomass' exposure to air pollution was the same.

**Conclusion:** Although the XRF method was limited by its Limit of Detection for several elements of interest it is a fast, non-destructive, and green screening method for the five elements mentioned earlier. Leaves exposed to higher levels of pollution (or older leaves), hence increased adsorption, could also be analysed for a much more comprehensive range of elements by the XRF method, as illustrated by the CRM recoveries.

S3-PP36

# Asbestos waste management: Microwave-assisted acid treatments as an effective procedure for the inactivation of chrysotile

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Chrysotile is a 1:1 phyllosilicate but its curved laminar structure generates particles with an achiral fibrous morphology normally rolled in the a-axis or, less commonly, in the b-axis. Suzuki et al. (2005) performed a pathological analysis of human lung tissue with mesothelioma in 168 individuals. In this study, 10575 asbestos fibers were less or equal to 5 µm, with a section less than 0.25 µm, and among the asbestos found in the tissue, chrysotile was the most common. These results suggested that short and thin asbestos fibers appear to contribute more to the formation of human malignant mesothelioma and should be considered as an important factor in the formation of asbestosis.
The present work has proved a novel procedure to modify the morphological and crystallo-chemical characteristics of chrysotile using microwave-assisted acid treatments. These treatments have eliminated Mg and Al cations located in the octahedral layer of the chrysotile structure in few minutes, producing the destruction of the original 1:1 structure and the lack of the flexibility of the fibers, while releasing amorphous silica. The secreted amorphous silica has continued to form part of the remaining fibers, leaving a skeleton that has maintained an elongated morphology with very rounded edges and very porous surfaces. In fact, microporosity has varied from 0, in natural chrysotile, to 138 m2 g-1 after 20 minutes of treatment. These skeletons of amorphous silica have not retained the physical resistance of the natural chrysotile fibers and are easily breakable, suggesting that the toxicity of the fibers has been inactivated. Although a more in-depth study would be necessary, these results indicate that microwave-assisted acid treatments can be an economical, fast and effective alternative in the management and transformation of the hazardous asbestos waste.

S3-PP37

# Leaching efficiency of elements from Zn-bearing ore under chemical and biotic conditions: a potential method for secondary recovery of elements

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The study area is located near the Olkusz city (South Poland) where Zn-Pb, and occasionally Ag bearing ores were exploited from the XII century up to 2020. Primary Zn and Pb were extracted from sulphides (sphalerite, and galena), and only occasionally Zn also originated from oxidized Zn ores (well known as calamines). The mining wastes and tailings exposed to weathering conditions in the Olkusz area reveal variable phase compositions and consequently these solids exhibit different susceptibilities to alterations. Weathering of Zn and Pb bearing wastes is associated with liberation of relevant amounts of metallic elements (e.g. Zn, Pb, Cd etc.) causing potential harm for the environment and human health. However, mining wastes could also be considered as secondary resources for the industry. Thus, chemical and biotic leaching methods could be applied generating profits to the industry and additionally helping in reclamation of former mining areas. In order to estimate the leaching efficiency of Zn, Pb, Cd, Tl, and Ge from a calamine sample, chemical and bioleaching experiments were conducted. One calamine sample gathered from weathering zone of the Olkusz-Pomorzany underground mine and it was treated by inorganic (0.1, 0.5, and 1.0 M H2SO4; 2 M HCl, and HNO3) as well as organic acids (citric and oxalic). Solutions were sampled after 48h. Except of short-term, long-term experiment was conducted treating calamine with 1 M H2SO4, and 2 M HCl acids and the leachates were sampled after 2, 4, and 7 days. Bioleaching experiments were carried out using Acidithiobacillus thiooxidans and Psuedomonas fluorescens bacteria during 30 days. The effect of different pulp densities (PD) (1, 2, 5, and 5% for chemical leaching, and 1, and 5% for bioleaching) on leachability of elements from calamine was also evaluated. Bulk chemical composition of calamine and chemical composition of leachates were determined using ICP-MS device. Chemical leaching experiments revealed that the most pronounced amounts of elements were observed for Zn (25 900 mg·kg-1), Pb (42 800 mg·kg-1), and Cd (105 mg·kg-1) as the result of H2SO4, citric, and HCl acids treatments, respectively. Elevated amounts of Zn (41 100 mg·kg-1) were also liberated from calamine in HCl. On the other hand, bioleaching experiments revealed that A. thiooxidans bacteria most effectively liberated the elements from solid phases, except for Pb that was mobilized at higher amounts by P. fluorescens bacteria. In all cases, PD 1% is the most appropriate condition for leaching efficiency.

S3-PP38

# Response of Living Benthic Foraminifera to anthropogenic pollution and metal concentrations in Saronikos Gulf (Greece, Eastern Mediterranean)

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The Saronikos Gulf, including the industrial zone of Elefsis Bay, is subjected to a variety of urban and industrial impacts that significantly contribute to environmental degradation. Benthic foraminifera comprise a significant component of meiobenthic communities and they are widely used as reliable indicators for the determination of the natural environmental and anthropogenic impact in shallow coastal systems. The present study analyses the living benthic foraminifera composition and its relation to environmental parameters such as grain size, organic carbon content, and heavy metal concentrations, from the surficial sediment layer collected in the Elefsis Bay and the Inner Saronikos Gulf in February 2016. Canonical correspondence analysis and Spearman's rho correlation show that the foraminiferal species composition is significantly influenced by the increase of organic carbon and Cu, Pb, Zn content. In particular, a relatively low diversity fauna dominated by the stress-tolerant species Ammonia tepida, Bulimina elongata, Bulimina marginata, and Nonionella turgida occurs in the restricted environment of the Elefsis Bay, demonstrating the negative environmental impact caused by the relatively elevated organic carbon and heavy metal contents.

S3-PP39

# Detection of post-fire soil contamination using inductively coupled plasma-mass spectrometry (ICP-MS)

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**Introduction**: The present study is being carried out to determine the heavy metal concentrations of soil samples from postfire urban and forest areas in Attica, Greece. In this study, an endeavour for the determination of the origin of the heavy metals is being conducted.

**Methods**: Two different techniques were applied for the extraction of the heavy metals. The aqua regia method according to ISO 11466 and the microwave digestion method according to ISO 16729. Certified reference materials (CRM) were used for the development of the methods. The metal extracts of 15 soil samples from the burned areas were analyzed with inductively coupled plasma mass spectrometry (ICP-MS) as analytical method.

**Results**: From the preliminary results of this study, the chemical analyses of some samples showed high concentrations for some elements. The measured values are being evaluated compared to the Dutch national background values (The New Dutch List 2000) and the mean chemical composition of soils (Kabata Pendias 2010). The evaluation of these analyses may indicate the origin of these metals in the area (geogenic or anthropogenic).

**Conclusions**: In this preliminary study, two different extraction methods were developed for the determination of heavy metals, using ICP-MS. The origin of these metals is a complex issue and as a result further investigations need to be performed in order to reach to a conclusion regarding the origin of these potentially harmful elements in postfire areas.

S3-PP40

# Novel geochemistry to determine the dynamics of land to lake transfers in the Lake Victoria basin to inform coordinated land-lake management strategies

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The Winam Gulf catchment of Lake Victoria in western Kenya has historically been affected by poor land management practices leading to soil erosion, acidification and loss of organic matter. A gap in data exists to better understand the influence of soil degradation on soil-to-crop dynamics for micronutrients essential for a healthy diet. Additionally, the transfer of potentially toxic elements from land-to-lake via sediment flows and dust transfer has consequences for the lake ecosystem and human health via the food chain.

Here we present geochemical data to demonstrate soil-to-sediment transfers from agricultural and urban environments for initial source apportionment analyses and reference to historical sediment inflows into the Winam Gulf from major river catchments that contribute up to 25% of total sediment inflows for the whole of Lake Victoria. Detailed geochemistry will build on previous work to model soil erosion/geochemistry in western Kenya1,2 to better inform the management of agricultural soils to reduce loss of productivity and lake ecology for the fisheries industry. Both are crucial to food security and livelihoods as key United Nations Sustainable Deliverables Goals (SDG 2,3,14) in the region, by helping to connect land and lake management stakeholders for a coordinated mitigation plan to address poor land-use management. These data are presented alongside consortia presentations detailing highly specialised chemistry using plutonium isotopes to measure the rate of soil erosion, modelling at scale soil-to-crop transfers of nutrients and changes in soil chemistry according to land clearance and farming mitigation approaches.

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S3-PP41

# Hydrogeochemical and nitrate isotope composition along the Asopos river basin, Greece

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The Asopos River basin is located in central Greece and specifically in the prefecture of Viotia and has a length of about 58 km. The river passes through urban areas until it flows into the Euboean Gulf. It also flows through the large industrial zone of the Oinofyta area, where the industries discharge their waste through pipelines directly into the river. In addition, wastes from agricultural activities and from residential areas are partly responsible for the quality status of river water. The Asopos river basin has a long history in terms of environmental pollution. There are several publications that focus mostly on soil and groundwater surveys, while limited geochemical analyses have been carried out for surface water. The purpose of this study was to investigate the geochemical evolution along the Asopos River through the collection of surface water samples in March 2023. In total, 15 surface water samples were collected from upstream near the city of Thiva to downstream close to the city of Oropos. Moreover, 3 samples were collected from 3 different pipelines, which discharge their wastewater directly into the Asopos river. Chemical analyses included the determination of major cations (Na+, K+, Mg2+, Ca2+), major anions (Cl-, HCO3-, SO42-), nutrients (NO3-, PO43-, NH4+), and metal(loids) (e.g., As, Cd, Cr, Ni, Pb). In addition, analyses of N stable isotopes (δ15N-NO3-, δ18O-NO3-) were applied to examine possible NO3- sources and N biogeochemical transformations. The results of the analyses will be evaluated based on the land uses and anthropogenic pressures prevailing in the area (agricultural activity, industrial activity, residential waste) but also on the basis of the geological formations.

S5-PP42

# Preliminary data of magnetic susceptibility from a pilot study for establishing the first Soil Geochemical Atlas of Hellas

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Magnetic susceptibility (MS) measurements have been used as a tool to investigate the impact of human activities on the soil environment (Blundell et al., 2009). Activities such as industrialization, mining, and transportation have led to increased concentrations of magnetic particles in soils (Jordanova et al., 2003). The identification and quantification of anthropogenic magnetic particles provide insights into the extent and dispersion patterns of environmental contamination caused by human activities and aids the development of remediation strategies. However, MS values are significantly influenced by the bedrock lithology and soil-forming factors. Thus, it can be challenging to differentiate between natural and anthropogenic signals in MS data.

In this study, we combined soil magnetic measurements and mapping using a geographical information system in an area of 2500 km2 in mainland Greece. The samples were collected during the systematic pilot soil survey for establishing the first Soil Geochemical Atlas of Hellas by the Hellenic Survey for Geology and Mineral Exploration, aiming at establishing the regional geochemical baseline (Kontomichalou et al. 2023). Although areas influenced by point-sources of pollution were avoided during sampling, the regional baseline could include, not only the natural background, but also anthropogenic signals from diffuse pollution, at least to some extent (Salminen and Gregorauskien, 2000). Mass-specific MS (χ) and frequency-dependent MS (χfd%) were measured in 164 top-soil (0 –20 cm), and when available, bottom-soil (20–40 cm) samples. The χ values ranged from 0.044 to 14.708 ×10–6 m3/kg in top-soil, and from 0.078 to 7.163 ×10–6 m3/kg in bottom-soil, indicating a wide variation in the concentration of ferrimagnetic minerals, such as magnetite and maghemite. Screening the frequency-dependent magnetic susceptibility (χfd%) could help identify natural or anthropogenic MS anomalies. The values of χfd% varied widely from 0.3–13.7%, but in almost half of analysed soil samples, χfd% levels suggested that pedogenesis was an important process. By contrast, soil samples with low χfd% values (<2%) accounted for only 6% of the data set. Such low values of χfd%, combined with high values of χ, could be related to parent primary minerals of igneous rocks and anthropogenic magnetic particulates (Blundell et al., 2009). To discriminate between the two sources, we compared top-soil and sub-soil values. We also plotted MS data at both frequencies over land-use and simplified lithological maps of the studied area. We found that in most cases magnetic enhancement was due to geogenic, rather than anthropogenic factors. The results of the study would be valuable in establishing the geochemical baseline of elements of the studied area.

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S5-PP43

# Closed mining waste deposits in the area of Pb-Zn Mine Mežica (Slovenia) and their influences on metal levels in sediments downstream

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The Mining waste deposits (MWDs) can be a source of pollution with potentially toxic elements (PTE) as well as a useful secondary source of raw materials. The results of more than 10 years of research on the impact of closed and abandoned MWDs of metal mines on the environment in Slovenia will be presented (Gosar et al, 2020; Miler et al., 2022 and references therein).

PTE contents in mining waste, bottom stream sediment and water were determined to define environmental burden according to regulation values. Influence of mining waste to sediment pollution was estimated. Furthermore, mineral phases in both solid materials were determined with the use of SEM/EDS. The results show that are investigated MWDs important source of PTEs in stream sediments and that PTEs mostly occur as fine-grained sediments. MWDs generally have the greatest impact on sediments in streams close to them. Because fine-grained material containing PTE is also transported over long distances, in some places high levels of PTE are also found in the sediments of major watercourses far from MWDs causing regional pollution. Main ore minerals are to some extent soluble in stream water. However, measured PTE leaching potential of MWDs is negligible. PTE levels in stream waters are low.

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S5-PP44

# Impact of mercury from metallurgical activities in the child population of Cedral, Mexico

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The results from this study provide an understanding of the the exposure of the children population in the urban area of Cedral, in North Central Mexico, to Hg associated with uncontrolled historical amalgamation residues (tailings). A moderate level of exposure to Hg (geometric mean 3.5 µg L−1) was identified in blood samples from school-age children. Tailings were partially reprocessed in the twentieth century to obtain the remaining Ag and Hg, modifying the chemical forms of Hg in the residue and producing inorganic Hg compounds. A result assessment shows the importance of inhalation as a significant exposure route as well as the bioavailability of the Hg chemical form. Hg° content in gaseous elemental mercury (GEM) reaches concentrations of up to 1793 ng m−3 in the atmosphere and, due to a low bioavailability, probably contributes only in small proportion to human exposure. Inorganic Hg compounds in the tailings generated during the reprocessing procedure are contained in the particulate fraction in the atmosphere (PM2.5; mean concentration 23.6 ng m−3) and may contribute in a higher proportion than GEM to human exposure, due to its higher bioavailability.

S5-PP45

# Metal(oid)s composition and human health risks assessment of PM10 collected in an urban area impacted by metallurgical activities in northern Mexico

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This study aims to assess the pollution degree and the potential health risks of metal(loids) in the atmospheric environment of Torreón, an important metallurgical center (northern Mexico). In this study, we analyzed metals in particles smaller than 10 µm (PM10), collected during 2018 at three sites inside the urban area.
Data assessment shows that all analyzed elements occur over a wide range of concentrations. The comparison of their concentration with available information related to the concentration value limits recommended by the WHO and the EPA indicates that Mn, Ni, As, Cd, Pb, Cr (as CrVI) exceed 19.4, 1.4, 41.6, 54.2, 41.7, 15.3 % respectively, their corresponding recommended limits. The health risk for noncarcinogenic elements (HI) revealed adverse effects for As, Mn, Zn (calculated from the concentration mean values); however, the assessment of the individual samples showed that for different percentages of samples, HI values are higher than the permissible limits (As = 54.8%, Cr = 0%, Mn = 58.9%, Ni = 1.4%, Zn = 100%, Cd = 31.5% and Ba = 1.4% for adults and As = 72.6%, Mn = 71.2% V = 1.4%, Ni = 2.7%. Zn = 100%, Cd = 37% and Ba = 2.7% for children)
The total cancerogenic risk values (TCRs) of As and Cr, (calculated from their concentration mean values) were higher than the acceptable limit (1.0 × 10−4) for adults and children. The children's TCR values for individual samples showed that a percentage of them exceeded the allowable limit for As, Cr, Co, Cd (As = 100%, Cr = 100%, Co = 2.7%, Cd = 45.2%) for children and for adults (As = 100%, Cr = 100%. Co = 2.7%, and Cd = 45.2%.)
Results suggest a serious health risk in polluted areas. The investigation in this study provides valuable information on health risk mitigation strategies for environmental managers,

S5-PP46

# Geochemical origin of Ni and Cr in ranker-type soils formed on serpentinites massifs in Serbia

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The paper presents the results of research on the content of accessible forms of Ni and Cr in the ranker-type soils that are formed on the serpentinites massifs in Serbia. Soil samples were taken from seven different locations across Serbia (Zlatibor mountain, Kopaonik mountain, Miroč, Maljen mountain, Bukovi, Suvobor and Bubanj Potok) at the altitude range between 100 and 1700 m. There were analyzed 46 soil samples in total. The concentration of accessible forms of Ni and Cr was determined by extraction in a solution of DTPA-TEA (pH 7.3, ratio soil and solution = 1:2) by optical emission spectroscopy with induced coupled plasma (ICP-OES).

The content of accessible Ni in the all examined soil samples of ranker-type soils varies from 68 - 920 mg/kg, while the most common results (about 70% of the total number of samples) vary from 200 - 600 mg/kg. The content of accessible Cr in all examined soils varies from 16 - 216 mg/kg. The content of both, Ni and Cr significantly exceeds the value limits in soils.
The results of the analysis of all soil samples of ranker-type soils refer to high concentration of accessible Ni and Cr and thus correspond to phytotoxic concentrations.
Given the fact that there are no anthropogenic sources of pollution nearby the investigation locations, it can be concluded that such a high concentration of accessible Ni and Cr in the ranker-type soils, that were formed on serpentinites massifs under the various pedogenetic conditions, is of geochemical origin. The geochemical distribution of Ni and Cr places this type of soil in the group of lithogenic soils.
Keywords: ranker-type soils, serpentinites massifs, accessible Ni and Cr, geochemical origin.

S5-PP47

# In2Air: establishing a baseline to evaluate the impact of 'net-zero' household energy interventions on energy use, indoor air quality and occupant self-reported general health and wellbeing.

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**Introduction**

Air pollution is one of the main causes of ill health and premature death worldwide. Given we spend a great deal of our time indoors, we need to make sure indoor air is safe to breathe. Homes also play a large part in greenhouse gas emissions and so the energy efficiency of homes is of international importance as we work towards net-zero. Tackling climate change, together with improving indoor air quality, offers a significant opportunity to improve residents' health and wellbeing. To do this requires the evidence base to energy efficiency retrofit.

**Methods**

This 6-month study, on 30 bungalows owned by Newcastle City Council and occupied by senior tenants (> 55 years), collected the following baseline datasets before the homes underwent a fabric-first intervention:

i) indoor and outdoor concentrations of PM10 and PM2.5
ii) indoor CO2 concentrations (used as a surrogate measure of ventilation in the home)
iii) outdoor and indoor temperature and humidity
iv) energy consumption data and associated survey, and
vi) self-reported general health and wellbeing using standard validated tools (SF-36v2, ICECAP-A) and Use of Health Care Services.

**Results & Conclusion**

Descriptive statistics are presented (e.g. average, maximum, standard deviation) along with the number of times guideline values are exceeded and key factors influencing baseline indoor PM and CO2 concentrations. Responses to the SF-36v2 and ICECAP-A surveys, converted using standard scoring algorithms, are compared with the environmental data. The 'Use of Health Care Services' converted into costs, energy meter readings, utility bills analysis and infrared thermal imaging, provide additional insight to quantify baseline conditions.

The In2Air study reports the baseline data to enable evaluation of the impact of retrofitting on indoor AQ, household energy use, and on general health and wellbeing.
The study's protocols are available at https://www.mapmyenvironment.com/in2air/

S5-PP48

# Reducing heavy metal emissions: positive effects of IMO's global sulfur cap 2020 on air quality at the port of Paranaguá

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Ships are key contributors to air pollution on a global scale. According to the International Maritime Organization (IMO), international shipping is responsible for around 2.2% of global greenhouse gas emissions. IMO's Global Sulfur Cap 2020 set a new sulfur limit of 0.5% m/m for Heavy Fuel Oil (HFO), reducing harmful emissions. The world fleet's daily consumption of 4.3 million barrels of HFO cause the release of high concentrations of vanadium (V) and nickel (Ni) into the environment. Both these elements are implicated in adverse health conditions, such as high blood pressure and cancer. However, the new regulations established by the IMO are expected to reduce pollution levels. As global monitoring of the impact of new legislation is limited, we examined the air quality at the Port of Paranaguá, the largest grain port in Latin America and the second-largest terminal in Brazil, prior to and after the switch to the new fuel. From 2019 to 2020, PM2.5 measurements were taken at the Port of Paranaguá using a Harvard impactor sampler. The PM2.5 was analyzed for its elemental profile, using the X-ray fluorescence (XRF) technique. As expected, the observed sulfur levels in PM2.5 reduced significantly from 2019 to 2020. Our study revealed a significant reduction of over 20% in the concentrations of V and Ni in PM2.5 from 2019 to 2020. This reduction is noteworthy as it indicates a substantial decrease in the number of harmful pollutants released into the environment, potentially reducing the impact on the health of nearby populations. Likewise, the V/Ni ratio decreased proportionally. In 2020, lower maritime emissions of heavy metals led to reduced inhalation exposure, HQ, and HI indices, decreasing the non-carcinogenic impacts of PM2.5. The study indicates that regulations on fuel have positive effects beyond the reduction of SO2 emissions. The findings suggest that other environmental factors in the port area also benefit from such regulations.

S5-PP49

# Urban air quality: a geochemical fingerprint of the geology-land-use-health-nexus

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The dynamics of population growth, innovation, and technological advancement have been a debate since the industrial revolution, wherein population growth is often seen as positively correlated with technological development. This normally leads to increased economic activity and urbanization, putting immense pressure on the local environment, causing various environmental issues such as air and water pollution, deforestation, climate change, and biodiversity loss. Balancing economic development with environmental conservation is crucial for a sustainable future. Sustainable practices in industries, urban planning, and households need to be followed, such as use of renewable energy sources and recycling systems. The increased demand on natural resources (including processing and disposal) in the quest to improve living standards, result in the emission of various types of air pollutant (gases, particulate matter) all potentially disrupting environmental dynamics and ultimately be toxic to terrestrial and marine organisms.

This study examined the atmospheric geochemistry in response to human impact on the environment in Joinville, an urban-industrial area on Brazil's southern coast known for its metalworking industry pole. Daily PM2.5 aerosol samples were monitored and analyzed for trace elements. These chemical results were then used to assess ecological and health risks during different horizontal wind regimes.

The chemical composition of PM2.5 in the region's atmosphere showed a geochemical footprint characteristic of the mineral resources consumed and processed by the prevailing types of industrial activity. Environmental limitations played a crucial role in controlling air pollution in this area, characterized by high precipitation rates and variable wind patterns. However, despite these constraints, the presence of PM2.5-bound elements indicated severe pollution and significant ecological risk. We observed that Co, Cr, Cu, Pb, Ni, Mn, and Zn loadings resulted in high non-carcinogenic and tolerable carcinogenic risks.

Our study suggests that the specific air pollution dynamics related to critical elements utilized by human activities should be taken into account when designing urban planning and development zoning regulations. Additionally, our results emphasize the need for effective air quality management policies in both the public and private sectors to safeguard the wellbeing of populations and the environment.

S5-PP50

# The impact of air pressure and temperature variations on gaseous and particulate pollutants from a Euro V-SCR engine fueled with biodiesel blends

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Although several nations have implemented biodiesel blending with urea SCR aftertreatment systems for heavy-duty diesel engines, there is still a lack of scientific consensus on their unregulated emissions. Additionally, there needs to be more research on how air pressure and temperature variations may impact the on-road emissions of heavy-duty vehicles using biodiesel blending. This study aimed to determine the gaseous and particulate emissions from a Euro V-SCR engine fueled with blends of soybean biodiesel (B8, B15, B50, B75, B100). For the B8 and B100 proportions, variations in the intake air's pressure (900 and 1000 hPa) and temperature (15 and 30 °C) were also evaluated. The experiments were performed on an engine emission bench using the European Transient Regime Cycle (ETC). The results regarding the permissible gaseous emissions suggest that increasing the amount of biodiesel in a diesel mixture, B8 to B100, is advantageous for CO (102 to 49 mg kWh-1) and NMHC (131 to 105 mg kWh-1) emissions; nevertheless, NOx (645 to 700 mg kWh-1) emissions showed an upward trend from B8 to B100. PAHs and Nitro-PAHs are associated with the total particulate matter and were quantified using a CG-MS/MS. For unregulated gaseous emissions, NH3 (3,8 to 10,1 mg kWh-1), N2O (51 to 102 mg kWh-1), and HCHO (5,45 to 6,80 mg kWh-1) indicated an upward trend when increasing quantities of biodiesel were employed, whereas SO2 (74 to 57 mg kWh-1) and HCD (137 to 111 mg kWh-1) emissions exhibited a downward trend. The PAHs with 3 and 4 aromatic rings were the ones that presented the highest emissions, and the Phenanthrene was the highest in particle emissions for all tested mixtures. PAHs also decrease with higher biodiesel percentages; however, the Total Equivalent Toxicity (TET) values increase considerably. The use of B100 doubled the TET values compared to B8 under all intake air temperature and pressure conditions. TET values indicated that 900 hPa and 15 °C are the least suitable for using B100. Based on this study, using up to 15% biodiesel in diesel blends does not negatively impact emissions and is not a counterpoint to the other benefits of biodiesel.

S5-PP51

# Impact of lanthanoid-enriched substrates on rare earth elements and yttrium uptake in vegetables

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**Introduction:**
Rare earth elements (REE), including yttrium (REYs), are elements essential for various technological applications. However, various processes can lead to increased levels of these elements in the environment and the food chain. In regions such as the Istrian Peninsula (Croatia) with naturally elevated levels of REYs and centuries-old mining and burning traditions, it is important to investigate the uptake of REYs in local vegetables. Therefore, the aim of this study is to investigate the uptake of REYs in vegetables from the Istria region.
**Methods:**
Soils and vegetables (fennel, garlic, lettuce, onion, parsley, and radicchio), including roots, stems and leaves, were collected from local gardens in the study area. Samples were totally digested with a mixture of concentrated acids, and REY concentrations were analyzed by inductively coupled plasma mass spectrometry.
**Results:**
The results showed that REY concentrations in the soils of the study area were generally higher than those reported in other regions. Interestingly, Y concentrations in root samples were almost 100 times higher than those of other rare earth elements, regardless of the type of vegetable. The highest average Y concentration (322 mg/kg) was found in lettuce, followed by onion (232 mg/kg), radicchio (221 mg/kg), garlic (189 mg/kg), parsley (112 mg/kg) and fennel (107 mg/kg). However, Y concentrations in stems and leaves were not significantly different from those of the other REEs.
**Conclusion:**
The high Y concentration in root samples suggests that Y can be selectively taken up by plant roots regardless of the type of vegetable. Further studies are planned to elucidate the mechanisms involved in Y uptake and to evaluate the potential health risks associated with exposure to REY from consumption of vegetables in this region. The results obtained also highlight the importance of understanding the global cycle of lanthanoids and their potential impact on human health.
This work has been supported by Croatian Science Foundation under the project FORtIS (IP-2019-04-9354).

S5-PP52

# The presence and mobility of strontium (Sr) in various fractions of thermally processed municipal waste

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Strontium is an alkaline metal commonly found in nature. Biogeochemical properties of strontium are similar to those of calcium and its Sr-90 isotope is easily absorbed by plants from soil and rapidly incorporated into the food chain, which entails a substantial environmental risk.
We used chemical analyses, such as: water leaching, with solid phase-solution ratio of 1:10, and aqua regia pseudo-total digestion (1:10 ratio), to determine the total and easily leached amounts of Sr in ash generated from the combustion of the following materials in domestic furnaces:
i) selected fractions of municipal waste (i.e. furniture, sponges, waste paper, PCV packaging, plastic-coated paper cartons, imitation leather, rubber, textiles and polystyrene, n=11),
ii) mixed municipal waste (n=3),
iii) conventional (n=3) and alternative (n=13) fuels.

Sr concentration in water solutions ranged from 0.08 to 6.09 mg/dm3, which equaled 4.31-302.37 mg/kg by weight. The largest amounts of Sr were leached from mixed waste (87–300 mg/kg), coals (90–521 mg/kg), rubber (242 mg/kg) and imitation leather (216 mg/kg).
The pseudo-total concentration of Sr in ash generated from the combustion of municipal waste ranged from 40 to over 1006 mg/kg. The largest amounts of Sr were found in ash obtained after combusting the following conventional and alternative fuels: coal pellets (488–1006 mg/kg), hard coal (430–670 mg/kg) and mixed waste (237–825 mg/kg). High concentrations of Sr were observed in ash generated from the combustion of acacia wood (440 mg/kg), imitation leather (423 mg/kg) and polystyrene (414 mg/kg).
The results obtained indicate that the most mobile fraction of this element (determining the environmental risk) comprised from 1.3 to nearly 100% of the total concentration. This result points to a low, medium or high environmental risk related to Sr leaching from ash formed after combusting municipal waste. This is important in the context of storing and securing landfills against the potential resuspension of the smallest ash particles by wind and their deposition on soils and plants (Kicińska et al. 2022, Kicińska & Caba 2021, Kicińska 2019, Kicińska & Mamak 2017).
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S5-PP53

# Geochemical and environmental characterization of biomass ashes after combustion of olive kernel residues in an electricity power plant. Implications for the waste management and sustainability

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Nowadays, the replacement of fossil fuels by biomass has been attractive worldwide because they are carbon-neutral and versatile in logistics. The utilized biomass fuels consist of residues coming from the process of woody products (e.g. sawdust and barks) agriculture and livestock (Vassilev et al., 2010). The abundance of olive tree groves in Greece, makes olive pomace a highly promising biofuel to contribute to the renewables' energy mix for the transition to the post-lignite era of the country (Vasilatos et al., 2021).
The combustion of biomass yields large amounts of ash, from 0.1% for wood biomass up to 46% for biomass mixtures with municipal wastes (Vassilev et al., 2010). Biomass ash consists of inorganic materials, authigenic or detrital, and of organic unburnt residues. Biomass ash consists of bottom ash (BA), which is the coarser particle fraction, collected in the bottom of the combustion chamber, and fly ash (FA), which is the finer fraction that is retained by the filtration system. The composition of biomass ash varies, depending mainly on the composition of the feed biomass fuel as well as, numerous anthropogenic factors (harvesting, processing, transportation, etc.) (Voshell et al., 2018). The fractionation of trace elements between fly and bottom ash is crucial for their utilization in secondary applications and/or their disposal in landfills (Vasilatos et al., 2023; Voshell et al., 2018). The present study focused to the geochemical and environmental characterization of both bottom and fly ashes generated from the combustion of olive kernel residuals biomass. Aiming to the chemical, mineralogical and physicochemical characterization of bottom and fly biomass ashes and to the determination of element distribution among their fractions. The chemical composition of biomass ashes includes major (C, O, H, N, Ca, K), minor (Si, Al, Mg, S, Fe, P, Cl, Na) and trace elements (Mn, Ti, etc.). The accumulation of trace elements in biomass ashes depends on their phyto-accumulation in the parent biomass from the soil, and plays a major role in the management of biomass ashes. Some of the trace elements, such as As, Be, Cd, Co, Pb, Mn and Ni, are regarded as potentially hazardous, whereas others such as Cu, Zn, Mo and Se are micronutrients essential for plant growth. Most of the trace elements identified, are present in all samples, except Mo, As, Cd and Sn which were not detected in BA samples.

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S5-PP54

# Full scale stabilization of lead in polluted soil using palygorskite clay

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Stabilization of PTEs in soils using palygorskite clay has been studied through laboratory and field-scale trials (Zotiadis et al. 2012; Tao et al., 2021; Liang et al., 2014), due to its large specific surface area, moderate cation exchange capacity and chemical and mechanical stability (Wang et al., 2018). Within this frame, this study presents a full-scale remediation project involving stabilization of lead (Pb) in polluted soil as part of a full-scale remediation plan combining in-situ stabilization, excavation and capping by using a geosynthetic clay liner. For the initial stabilization of Pb in soil, palygorskite clay, a commercial product of Geohellas S.A., Sanfed Powder F, was used. A laboratory-scale experiment was run in parallel with the field scale application. Contaminated soil was collected and subjected to three different treatments in the lab. The treatments were monitored for 5 weeks after which leaching experiments were conducted on each treatment according to EN 12457-4 (2003), and lead (Pb), arsenic (As), copper (Cu), zinc (Zn) and antimony (Sb) concentrations of the extract were determined by ICP-MS. The application of palygorskite clay to the contaminated soil did not significantly affect physicochemical soil properties (pH, TDS). A significant reduction in the water-extractable concentration was detected for Pb reaching 55% and a comparable 63% reduction in Pb concentration was observed under field conditions. Additionally, a significant Zn reduction reaching 75% was observed. The soil, according to Directive 33/2003, after stabilization can be categorized as inert waste for the elements Pb, As, Zn and Cu and as non-hazardous waste for Sb. The application of palygorskite clay to the soil proved to be an effective stabilization method for PTEs, as palygorskite significantly reduced Pb and Zn mobility in soil under normal geochemical conditions and reduced dispersion risks during the subsequent stages of site remediation.

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S5-PP55

# Possible toxicity of Potentially Harmful Elements in Geophagic clays: Case studies from parts of Southeast Nigeria

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Geophagic clays are consumed and applied topical by adults and children in Calabar and Okon-Eket areas of southeast Nigeria; and traditional, cultural and cosmetic reasons are adduced for this practice. Their essential nutrient content notwithstanding, the clays were assessed in order to evaluate possible toxicity of Potentially Harmful Elements (PHEs)- Cd, As, Pb, Cu and Zn (CALCZ). Thirteen clay samples were obtained from markets and clay mines; air-dried, pulverized and analysed for their elemental constituents using Inductively Coupled Plasma Mass Spectrometry (ICPMS). Index of Geoaccumulation (Igeo), Contamination Factor (CF) and Degree (CDeg), Pollution Index (PI), Ecological Risk Factor (Er) and Index (RI), Hazard Index (HI) and Cancer Risk Index (CRI) were used for ecological and health risk assessments of the clays. Results revealed PHE concentrations (ppm) in the order: Zn (13.0-148.0) > Pb (16.7-55.6) > Cu (5.7-23.0) > As (BDL-15.0) > Cd (BDL-0.2). Igeo values for Cd, As, Cu and Zn in the clays were <0, while Pb had a value of (-1) to 1. The clays from Calabar and Okon-Eket had Pb CF values of 1.8 and 1.7, and PI values of 1.4 and 1.3, respectively. Moderate Pb contamination was detected in the clays, but low HQ and HI of the PHEs indicates that they pose no immediate risk of non-carcinogenic nor carcinogenic effects to geophagic individuals. However, the moderate Pb contamination in the clays is a source of health concern, especially for geophagic children.

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