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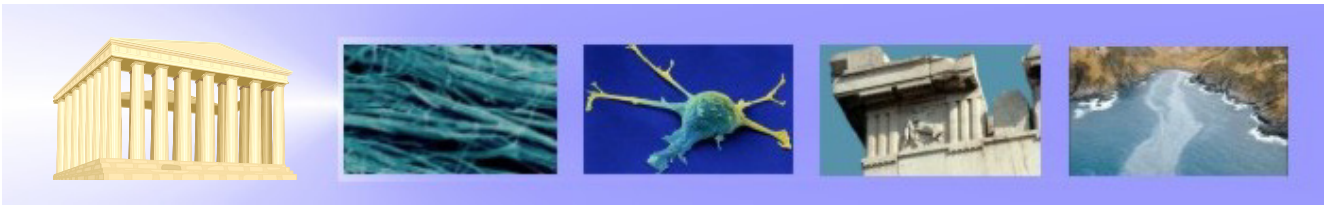

26th EUROPEAN CONFERENCE

"HEALTH IMPLICATIONS OF ENVIRONMENTAL CONTAMINATION"

31st March – 2nd April 2008
Athens, Hellas

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26TH European Conference
Society of Environmental Geochemistry and Health

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09.20 - 09.30	Welcome address	**Emmanuel Baltatzis** ***President of the Faculty of Geology and Geoenvironment University of Athens***
09.30 - 09.40	Welcome address	**Niki Goulandri** ***Honorary Chair of SEGH 2008***
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*Student presentations for Hemphill award

MONDAY 31 MARCH (continued)

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*Student presentations for Hemphill award

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*Student presentations for Hemphill award

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*Student presentations for Hemphill award

Profiles of Conference Keynote Speakers

David Gee
European Environment Agency, Copenhagen, Denmark

David Gee was educated in politics and economics and has worked for over 30 years at the science/policy interface of occupational and environmental risk assessment & reduction, with UK Trade Unions; the Environmental Group, Friends of the Earth, where he was Director; and, since December 1995, with the European Environment Agency, an EU information providing body in Copenhagen, where he is responsible for "Emerging Issues and Scientific Liaison" and Group leader for Science, Policy and Innovation. He has published reports and lectured on many issues, including Scientific Uncertainty,; the Precautionary Principle, Environmental Health, Environmental Taxes and Ecological Tax Reform, and Clean production/ Eco-efficiency.

Prof. Luc Hens
Vrije Universiteit Brussel, Belgium

Luc Hens graduated as a Biologist and later received his Ph.D. in Biology from the Vrije Universiteit Brussel (Belgium), where he is at present Professor and Head of the Human Ecology Department. He also lectures at the Technical University of Sofia (Bulgaria). His specific area of research concerns the elucidation of interdisciplinary instruments for sustainable development. Professor Hens acts as an expert on environmental policy in several advisory councils in Belgium. He is the book review editor for the International Journal on Environmental Pollution, and editor of "Environment, Development and Sustainability". He currently acts as vice-dean for educational affairs of the Faculty of Medicine and Pharmacy, of which the human ecology department is part of.

Prof. Klea Katsouyanni
National & Kapodistrian University of Athens, Hellas

Klea Katsoyanni is Professor in Medical Statistics and Epidemiology at the University of Athens Medical School. She has worked in Environmental Epidemiology for more than 20 years and is the Coordinator of the APHEA (Air Pollution and Health: a European Approach) network, a E.C. funded project which was established in 1992 and produced results which have contributed to the understanding of the air pollution health effects in Europe and the establishment of legislation for the management of air quality. She has been a member of several advisory Committees (E.C., W.H.O., etc.) in environmental health topics. She has more than 120 publications in peer reviewed journals, which have been cited more than 3500 times. She was awarded the 2006 Goldsmith award for sustained and outstanding contribution to the knowledge and practice of environmental epidemiology by the International Society for Environmental Epidemiology.

Prof. Anthony J Newman Taylor
National Heart and Lung Institute, Imperial College London, UK

Professor Anthony Newman Taylor is Head of the National Heart and Lung Institute, Faculty of Medicine, Imperial College, and Head of the Department of Occupational and Environmental Medicine at National Heart & Lung Institute, Imperial College, London. He has worked as Consultant Physician at Royal Brompton Hospital since 1977, currently been a Non-Executive Director, Royal Brompton & Harefield NHS Trust. He is also Chairman of Industrial Injuries Advisory Council, an expert advisory group to Department for Work and Pensions. His major clinical and research interests have been occupational lung diseases, asthma and eosinophilic lung diseases.

Assoc. Prof. Polyxeni Nicolopoulou-Stamati
National & Kapodistrian University of Athens, Hellas

Polyxeni Nicolopoulou- Stamati is a qualified Pathologist- Cytologist. She currently holds the position of Associate Professor of Pathology, teaching at the Medical School of the National University of Athens. She also works as invited professor at the VUB, teaching in the Master and Postgraduate Diploma programmes in Human Ecology. She is experienced in organising seminars, intensive courses and congresses, in building medical curricula and coordinating European Projects. She has worked as an Expert at the European Commission and has been the coordinator of the EU funded AREHNA (Awareness Raising about Environment and Health of Non-expert Advisors) project. At present she is the scientific coordinator of a 2 year Master programme of the Medical School of University of Athens entitled: “Environment and Health, Capacity Building for Decision Making”.

Dr Olle Selinus
Geological Survey of Sweden

Dr. Olle Selinus is a geochemist at the Geological Survey of Sweden (SGU). During the 1960s and 1970s he worked in mineral exploration and since the beginning of the 1980s his research work has been focused on environmental geochemistry, including research on medical geology. He is the organiser of several international conferences and has published over 80 manuscripts. Currently in charge of research and development at the geological survey. He serves as Editor-in-Chief for the book on "Essentials of Medical Geology", associate editor of Applied Geochemistry, officer of the Association of Applied Geochemists, and as president of the International Medical Geology Association. He has received several international awards and has been appointed Geologist of the Year (2005) in Sweden because of Medical Geology. He is also chairing the "Earth and Health" team of the United Nations initiative International Year of Planet Earth, member of the organising committee and vice president for the 33 International Geological Congress in Oslo in 2008, vice chairman of the National Committee of Geology at Swedish Royal Academy of Sciences, chairman of the Swedish National Committee of the International Year of Planet Earth.

ORAL PRESENTATIONS

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KEYNOTE

ENVIRONMENT AND HEALTH: FOCUSING ON ENDOCRINE DISRUPTION

Polyxeni Nicolopoulou-Stamati

University of Athens, Medical School, Athens, Greece pstamati@med.uoa.gr

Disease is a part of life and has always been the outcome of imbalance between man and nature. In antiquity elements of nature such as fire, water, air, soil and metals were worshiped and used in everyday life as pure and good. Medicine through ages recognized metals that are abundant in nature, as elements when in traces, essential for normal function and enzyme production in the body but disastrous in high concentrations.

Geology has an important role in determining concentrations of natural elements in the environment, furthermore is capable of giving information on their reactions, interactions, acidification and complexity respectfully. However the wide use of different natural elements in combination with industrialization (lead is a clear example) plus the wide production of man made chemicals has totally affected nature. Higher concentration of metals because of human activities (example Cadmium) and newly made chemicals rapidly evolving have left behind legislative reforms and new technologies that could have aligned progress with protection of life and health.
The living creatures with man in the center have lived for millions of years in a "clean" balanced environment that has been heavily polluted the last 80 years. Hormones circulating in the blood stream of living creatures had a clear pattern of action: Receptors were made to react safely with hormones produced by the body. Man made chemicals and their byproducts (PCB's, dioxins), plus high concentration of metals are affecting the human being, exposed to the new only 80 years altered environment, through a very specific property: endocrine disruption.

Endocrine disruption is the disruption of the activities of the hormonal system by substances that are mimicking hormones and are responsible mainly for reproductive disorders. Exposure of the mother also may affect the fetus while in the uterus with neurodevelopmental disorders, congenital diseases but also cancer in later life.

References

1. Endocrine disrupters: Environmental health and policies, **Editors:** P. Nicolopoulou-Stamati**;** Luc Hens**;** Vyvyan Howard**,** Dordrecht; Boston: Kluwer Academic Publishers, ©2001
2. Cancer as an environmental disease, Editors: P. Nicolopoulou-Stamati; Luc Hens; Vyvyan Howard, Dordrecht; Boston: Kluwer Academic Publishers, ©2004

KEYNOTE

LATE ONSET ENVIRONMENTAL STRESSORS: THE IMPLICATIONS FOR EARLY PREVENTION

David Gee

Strategic Knowledge and Innovation, European Environment Agency

Developmental and reproductive toxicants that cause serious disease and dysfunction, either lifelong or occurring late in life, can be initiated in the early life stages of human beings and other species. It is often the timing and the dose more than the dose itself that distinguishes harmful from harmless exposures to such toxicants. As much of the harm is irreversible, and sometimes multigenerational, the timing of actions to prevent such harm is also critical. In determining when there is a sufficiency of evidence to justify early prevention of harm, decision-makers need to take account of the implications of multicausality, the methodological biases within environmental sciences, and the need to take precautionary, as well as preventive actions to eliminate or reduce exposures. The widely used Bradford Hill causal 'criteria' are briefly reviewed light of multicausality. Reaching agreement between stakeholders on a sufficiency of evidence for early action to reduce exposures to toxicants requires the consistent use of transparent definitions of the concepts and terms used to characterize the strength of evidence between causes and effects. Proposals are made to improve those in current use, including a definition of the precautionary principle.

PENTACHLOROPHENOL IN QUERCUS SUBER FORESTS: A PILOT STUDY IN TUNISIA (A NATO SCIENCE FOR PEACE PROJECT)

Iain McLellan[1]*, Cátia Rodrigues[2,3], M. Cristina Leitão[2], Adélia Valera[2,4], Mariana B Carvalho[2], Isabel Martins[2], Helga Garcia[2], Marija Petkovic[2], M Hassen[5], Andrew Hursthouse[1], Vitória San Romão[2,3,6] and Cristina Silva Pereira[2,3]

1. School of Engineering & Science, University of the West of Scotland, Paisley, PA1 2BE, UK
2. Instituto de Tecnologia Química e Biológica – Universidade Nova de Lisboa (ITQB-UNL), Apartado 127, 2780-901 Oeiras, Portugal
3. Instituto de Biologia Experimental e Tecnológica (IBET), Apartado 12, 2780-901 Oeiras, Portugal
4. Estação Agronómica Nacional (EAN), Av. da República, Quinta do Marquês, 2784-505 Oeiras, Portugal
5. CERTE, BP 273, Route Touristique Borj Cedria, Soliman, 8020, Tunisia
6. Estação Vitivinícola Nacional (EVN), Dois Portos

Persistent organic pollutants (POPs), such as organochlorine pesticides and herbicides, are a local and global environmental concern due to their recalcitrance in soils, long range transport and bioaccumulation within terrestrial & aquatic organisms and humans. Agro-forestry ecosystems are treated with a cocktail of man-made chemicals which causes soil, water and air contamination; whilst the agricultural aspect is often considered, the forest side is largely neglected due to the mistaken believe that these are non-polluted environments. A particular POP of interest is pentachlorophenol (PCP) which was widely used from the 1950s onwards as a preservative, biocide, herbicide and pesticide. Concerns raised during the 1980s regarding its health effects on humans, led to the implementation of widespread restrictions on its use. The environmental concern of PCP is increased when its many metabolic transformation products are taken into consideration, some of which are more toxic to organisms than PCP itself.

Quercus suber (cork oak) forests were selected for PCP monitoring because of their local and regional economic importance. The presence of PCP fungal metabolites found on cork slabs indicates the dispersal of PCP, and its transformation products, within the oak forests. Whilst PCP fate within specific environments has been previously studied, the *NATO Science for Peace* project (UK, Portugal, Italy, Tunisia and Morocco) is the first to analyse PCP fate within cork forests. As part of a pilot study, soil samples were collected from Tunisian oak forests in summer 2007. Initial analysis by the UK team found that there was widespread PCP contamination; the Portuguese team focused on fungal diversity and found a decrease in diversity with increasing concentration. Future work will include the identification on non-identified species, the chemical fingerprint of contaminants present and the integration of data from all partners to allow the correlation between contamination, soil and microbiota.

FIELD MEASUREMENTS OF *IN SITU* SOIL CONTAMINANT HETEROGENEITY TO CREATE MORE REALISTIC POT TRIALS FOR THE ESTIMATION OF PLANT UPTAKE

J. Y. Thomas[1]*, M. H. Ramsey[1], E.A.John[1] and B.Barnes[2]

1. Department of Biology and Environmental Science, School of Life Sciences, University of Sussex, Falmer, Brighton, BN1 9QG. * jyt21@sussex.ac.uk]
2. Environment Agency Science Group, Midlands Regional Office, Sapphire East, 550 Streetsbrook Road, Solihull, West Midlands, B91 1QT

Soil contaminant concentrations are well known to often be very heterogeneous and this has been recently quantified by *in situ* measurement techniques[1]. One of the unexpected consequences of this heterogeneity is that it can significantly affect the uptake of the contaminant by plants[2,3]. This has implications for estimates of plant uptake coefficients used in human health risk assessment associated with the ingestion of food plants grown on contaminated soils. Previous pot trials to investigate this effect have used simple 'chequerboard' designs with only two extreme values of contaminant concentration. Whilst simplistic in their approach, pot trials still have a considerable advantage over growing plants in real contaminated soils, in that each contaminant can be investigated in isolation.

This research aims to use patterns of 'real' heterogeneity, measured at two contaminated sites, to recreate more realistic patterns of heterogeneity in pot trials, designed to estimate plant uptake coefficients. The *in situ* measurements taken at these two sites (using P-XRF) will be presented, with the estimates of *in situ* heterogeneity for four elements (Pb, Zn, Cu and As). Computer simulations have been used to recreate approximations of *in situ* patterns for use with pot trials on four plant species (*Brassica juncea, Brassica napus, Taraxacum officinale* and *Plantago lanceolata*). The feasibility and advantages of this approach to improving the accuracy of plant uptake coefficients, used in human health risk assessments via food plant ingestion pathways, will be discussed.

[1]Taylor, P., Ramsey, M. H. and Potts, P. J.. 2005.. *Journal of Environmental Monitoring*. 7 : 1

[2]Millis, P. R., Ramsey, M. H. and John, E. A., 2004.. *Science of the Total Environment*, 326: 49

[3]Podar, D. Ramsey, M. H. and Hutchings, M. J.. 2004.. *New Phytologist*. 163 : 313.

THE ROLE OF ON-SITE MEASUREMENT IN THE ASSESSMENT OF HAZARD, EXPOSURE AND RISK

K.A. Boon[1]* and M.H. Ramsey[1]

1. Department of Biology and Environmental Science, School of Life Sciences, University of Sussex, Falmer, Brighton, BN1 9QG. * k.a.boon@sussex.ac.uk

In order to assess the risk to human health of land contamination it is important to characterise the hazards on the site, as well the exposure. Failure to correctly identify these areas of contamination and the exposure pathways can potentially result in consequences that are both costly and harmful to human health and the environment.

It is impossible to characterise the whole site and therefore appropriate representative samples need to be taken to assess the hazard. Ideally a large number of samples are required to give good site coverage so as to characterise a site well, however due to cost of traditional off site analytical methods the number of samples it is possible to analyse is limited. Also the turn-around time of these traditional methods is often lengthy resulting in delays and return trips to the site. Both these limitations of the traditional methods can however, be overcome with the use of on-site measurement tools. The lower cost per sample of the kits and the rapid measurement times can result in a large number of samples over the whole site with the acquisition of real-time data. Thus important decisions about the extent of contamination, and its potential for causing excess exposure to those at risk, can be made on site.

As well as use in the characterisation hazard the use of on-site tools is also potentially invaluable in the measurement of ambient pollution concentrations for the estimation of exposure, and can therefore aid in risk assessment. The use of on-site tools, as with their use in hazard assessment, can mean a higher number of real-time measurements, and can allow flexibility in the sampling protocol. For example, high concentrations of contaminants found near a source could trigger measurements near the receptor on the same day.

As with all measurement processes (including sampling, sample prep and analysis) there are errors involved and therefore uncertainties associated with the measurements produced by on-site tests. Unlike with the traditional methods, there is a lack of confidence in the on-site techniques. However, if the measurement uncertainty is estimated and quoted with the measurement, more confidence can be given to the measurements from these techniques by including the estimated uncertainty into the risk assessment.

THE CHEMICAL HAZARDS AND POISONS DIVISION (CHAPD) AND ENVIRONMENT AGENCY HORIZON SCANNING COLLABORATION

Patrick Saunders[1], Graham Urquhart[1]*, Sarah Bardsley[2], Jennifer De Lurio[2], Malcolm Gorton[2], Peter Simpson[2], and Sarah Webb[2].

1. Health Protection Agency, Chemical Hazards and Poisons Division, Centre for Radiation, Chemical and Environmental Hazards, Chilton, Oxon, OX11 0RQ
2. Environment Agency, Horizon Scanning and Technologies, Science Department, Environment Agency, Rivers House, Lower Bristol Road, Bath, BA2 9ES

Horizon scanning is the identification of new science, technology and social trends that are at the margins of current thinking. The Health Protection Agency (HPA) must be able to identify emerging threats to public health in order to provide a timely and effective response. Specifically, the Chemical Hazards and Poisons Division (CHaPD) must predict and prevent exposures to environmental health hazards such as chemicals.

The Environment Agency has a specialist team of horizon scanning scientists that routinely assess, catalogue and summarise a broad range of emerging sciences and technologies. Evidence is gathered and analysed within a bespoke database. Auto classification and visualisation tools are being tested and developed to aid the identification, categorisation and prioritisation of emerging trends in science and technology that present future issues or opportunities for the environment.

The evidence gathered by horizon scanning can be a useful source of information on emerging issues that are relevant to contaminated land and health. Examples of emerging technologies identified in the database include remediation of contaminated land by genetically modified plants or synthetic organisms. The database also contains links to information that might be useful for the identification of contaminated sites e.g. maps produced by the KGB identifying previous ministry of defence locations deliberately not mapped by ordnance survey for security concerns, that might be sources of contamination.

Horizon scanning is a vital tool to prepare for future developments that might come from areas of work outside of typical traditional topics that are routinely studied. Continuous and systematic scanning of the broad science and technology horizon is a monumental task, and very resource intensive. Collaboration between agencies should improve data robustness, reduce duplication, and increase efficiency. The pilot collaboration between the Environment Agency and the Chemical Hazards and Poisons Division is exploring the practical aspects of developing this work further and combining expertise from both organisations.

KEYNOTE

EFFECTS OF AMBIENT PARTICLES ON HEALTH

Klea Katsouyanni

Department of Hygiene, Epidemiology and Medical Statistics, University of Athens Medical School

In the first half of the 20th century, severe air pollution episodes (including elevated concentrations of particles) in Northern Europe and North America resulted in very severe health effects, with thousands of deaths attributed to air pollution e.g. in London in December 1952. In those areas legal and other measures led to a substantial decrease in air pollution concentrations, followed by the belief that those relatively lower levels did not have adverse effects on human health.

During the last 15-20 years results originating mainly from epidemiological studies consistently indicated that in current ranges of pollution, higher ambient particle concentrations, especially from smaller particles, those with an aerodynamic diameter <10μm (PM_{10}, $PM_{2.5}$, black smoke, PM_1 etc), had important effects on health including an immediate and long-term increase in mortality. Thus, from the multi-center European study APHEA, it is estimated that an increase of 0.5% in the total daily number of deaths is associated with 10μg/m^3 increase in PM_{10} concentrations (average of 2 days). This is mainly due to deaths from cardiovascular and respiratory causes and is more pronounced for the elderly and those suffering from chronic respiratory conditions. Also per 10μg/m^3 increase in PM_{10} we observe about 1% increase in emergency admissions for respiratory causes and 0.8% increase in ischaemic heart disease admissions among the elderly. Consistent results for acute effects are found in other parts of the world.

A few cohort studies have assessed the effects of long-term exposure to ambient particles. The first two (the Six City Study and the ACS study) were done in the US and found e.g. that living in the most polluted (PM2.5 concentrations were 34μg/m^3 at the beginning of the study and 20μg/m^3 at the end) versus living in the least polluted city (corresponding concentrations were 9 and 5μg/m^3) led to an increase of 6% in mortality from all causes, particularly pronounced for cardio-pulmonary causes and lung cancer; other factors related to death from those causes were adjusted for. More recently 3 cohort studies from European countries (The Netherlands, France and Norway) gave analogous results. An attempt to calculate the life lost from this exposure led to an estimation by the E.C. Programme "Clean Air For Europe" that in the year 2020, if we continue without additional measures to decrease ambient particle concentrations, 5.5 months will be the average loss in life expectancy in Europe (25 countries).

Studies trying to identify the biologic mechanisms of effect have generally supported epidemiologic findings. Furthermore, the beneficial consequences of specific reductions in air pollution have been documented.

In conclusion, current air pollution concentrations, especially ambient particles, constitute an important public health problem in Europe, North America and Worldwide.

KEYNOTE

HEALTH IMPACT ASSESSMENT OF MOTORIZED MOBILITY

Luc Hens

Department of Human Ecology, Free University of Brussels, Laarbeeklaan 103, B-1090, Brussels, Belgium.

Today rapid urban development occurs in many countries across the world; most often this causes increased numbers of passengers and freight moving within and between urban areas. This mobility also tends to involve longer distances and faster transport modes. The presentation will overview the health impacts linked to motorised mobility. Then, a case study on Hai Phong city, Vietnam will be developed, where data on the evolution of transportation are presented and the preliminary results of the health risk assessment will be discussed.

Air pollution caused by transportation and mobility imposes health risks on the population, ranging from disturbance and annoyance to lung illnesses, asthma, heart-rhythm problems, Chronic Obstructive Pulmonary Disease (COPD), and lung cancer, coronary heart disease, and pre-mature death. Noise has several adverse effects on communication, sleep and temper, as well as cardiovascular effects and hearing impairment. An increasing transport sector also entails an increasing risk of accidents. For example, about 127.000 lives per year are claimed by road traffic accidents in the European region. In Europe, pedestrians account for around 25 to 30 % of deaths and 13 % of injuries, and cyclists for 5 to 6 % of death and 7 to 8 % of injuries. Drivers comprise over 60 % of deaths and 60 % of injuries[1].

In the Hai Phong case study, the mobility pattern and its accompanying environmental and health impacts are assessed. According to the development plans of Hai Phong, the transportation will increase by about 30% for all means of transport by 2020. This increase will lead to a 30% increase in emissions of air pollutants. An increase of 10μg/m3 of PM10 can lead to 4.3% extra cases of mortality (Kulzin et al 1999). In Hai Phong, air monitoring data in 2007 shows an annual average of 45 μg/m3 of PM10 which leads to around 1,100 extra cases of mortality in the group +30 year-old.

[1] Book: Environmental Health Impacts of transport and mobility. Edited by P. Nicolopoulou-Stamati, L. Hens and C.V. Howard. Published by Springer. 2005.

EXTENDED IMPACT PATHWAY APPROACH – NEW GENERALISED RESULTS FOR USE IN LIFE CYCLE IMPACT ASSESSMENT, INTEGRATED PROJECTS AND OPTIMISATION MODELS

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Air pollution mostly dominates the human health (HH) damage category in life cycle impact assessment (LCIA). The substances have also an impact to building materials, crops and loss of biodiversity. Global warming contributes to the impacts to HH and environment also in different ways. Results of LCA have to be weighted to allow a ranking of alternatives for aiding decisions. We derived generalised factors (GF) per unit of release of important pollutants. GF mean: not for distinct point sources but for whole countries and for economic sectors. It is essential to take into account, that this assessment is time and space dependent, i.e. the damage caused by the release of one unit of a substance is dependent on where and when this release occurs. Country specific and European average values can be applied in LCIA, LCA, energy-, and integrated assessment modelling and optimisation. The factors include different ways of weighting and express the impacts per emission of the pollutants SO2,NOx, NH3, PPMcoarse, PPM2.5 and NMVOC, heavy metals, POPs, radionuclides CO2 and other GHG are provided as: [Euro per ton], [DALY per ton], or [intake fraction per ton], etc.. The updated and extended impact pathway approach provides results which are more reliable and conclusive because it combines site specific assessment, as far as possible, but also includes approaches where knowledge of causalities are less known. The approach and results are far from "holistic environmental assessment" but it is open and will include any further developments. The uncertainties are quantified and described. The user has to check the robustness of his results when comparing alternatives because the uncertainties are inherent in any LCIA methodology. The results will be able to support decisions and test more simplified approaches in the future. Next steps are: evaluation of emissions and impacts taking place in other regions (e.g., also in developing countries), assessment of exposure (including indoor exposure), extension of list to further substances, assessment of uncertainty regarding the robustness of the results.

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LUNG DOSE FROM MINERAL SAHARAN DUST TO GREEK RESIDENTS

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The Sahara desert is one of the major sources of mineral dust on Earth, producing up to 2 10^8 tons/yr. Under certain weather conditions, dust particles from Saharan desert get transported over the Mediterranean sea and most of Europe. In the past decades, several studies have shown a clear connection between suspended particulate matter and health effects. Thus, the European Commission has established PM_{10} limit values for PM monitoring in the air quality directive EC/30/1999. The limiting values can easily be exceeded by naturally produced aerosols, like desert dust, in all south European areas and especially urban. Firstly, in this study, the effects of dust transport on air quality in several Greek urban areas are quantified. To this end, PM_{10} concentration values from stationary monitoring stations are compared to dust concentrations for the 4-year period 2003-2006. The dust concentration values in the Greek areas were estimated by the SKIRON modelling system (Kallos *et al.*, 1997) coupled with embedded algorithms describing the dust cycle (Nickovic *et al.*, 2001). Dust contribution to PM_{10} concentrations was found to be greater than 10% in the urban areas throughout the years examined. In cases of exceedances - PM_{10} values greater than EU limits - natural dust aerosols may contribute by 20% to the airborne particulate matter, depending on the specific monitoring location. In a second stage of the study, the inhaled lung dose received by the residents in Greek urban areas is calculated. The particle deposition efficiency of mineral dust at the different parts of the human respiratory tract is determined by applying a lung dosimetry numerical model (Mitsakou *et al.*, 2005), which incorporates inhalation dynamics and aerosol physical processes. The lung dose from mineral dust particles was greater in the upper respiratory system (extrathoracic region) and less significant in the sensitive alveolar region. However, in severe dust episodes, the amounts of mineral dust deposited along the human lung are comparable to those received during exposure in heavily polluted urban or smoking areas.

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PROVENANCE STUDY OF PM_{10} AND $PM_{2.5}$ FROM AN URBAN SITE OF NORTHERN GREECE

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The aim of this study is the characterisation of minute airborne particles collected from the city of Kozani (Western Macedonia), northern Greece. Over a period of one year (March 2003 to February 2004), data was collected by a stationary collector placed near Kozani's centre. PM_{10} and $PM_{2.5}$ (particulate matter with a diameter lower than 10μm and 2.5μm respectively) were collected on teflon filters. The sampling took place on six randomly chosen dates, covering all seasons. Environmental Scanning Electron Microscopy (ESEM), coupled with Energy Dispersive X-Ray analysis (EDX) was employed for the characterization of the airborne particles. Several square centimeters of filter paper were cut from the centre of each sample, and examined within the ESEM without any form of preparation (i.e. no gold or carbon coating). A Philips XL30 environmental scanning electron microscope (ESEM), equipped with a LaB_6 filament, was used to image and elementally analyse the filter papers of the present investigation. Imaging was predominantly carried out in backscattered electron mode (BSE). Elemental analysis was carried out by energy dispersive X-ray analysis (EDX), under the same operational parameters as for imaging. The EDX spectra of the blank PM filters were also obtained and their composition was manually subtracted during the evaluation of the EDX spectra of individual airborne particles. Special consideration was taken when dealing with ultrafine particles (<2 μm), in order to avoid interference from the filter.

Particles are categorized as geogenic, biogenic and anthropogenic. Carbonates, silicates and heavy minerals are the main airborne particles with a geogenic origin. Pollen/spores and diatoms are included in the identified biogenic particulates. The main anthropogenic airborne particles are

- fly ash, released from several lignite-fired power stations located in this large, intensively exploited area,
- carbonaceous (soot and char) and
- metalliferous (mainly iron and copper enriched) particulates.

ENVIRONMENTAL IMPACT OF MT. ETNA'S VOLCANIC EMISSIONS: TRACE METAL BULK-DEPOSITION

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Volcanoes contribute to atmospheric pollution by increasing the amount of reactive and greenhouse gases and aerosols, making volcanic emissions one of the major natural sources of several trace elements to the atmosphere. In particular, Mt. Etna is considered to be, on the long-term average, the major atmospheric point source of many environmental harmful compounds. Their emission occurs either through continuous passive degassing from open-conduit activity or through sporadic paroxysmal eruptive activity, in the form of gases, aerosols or particulate.

To estimate the environmental impact of magma-derived trace metals and their depositions processes, five bulk collectors have been deployed at various altitudes on the upper flanks around the summit craters of the volcano. Samples were collected every second week for a period of one year and analyzed for the main chemical-physical parameters (electric conductivity and pH) and for major and trace elements concentrations.

The first data obtained clearly show that the volcanic contribution is always prevailing in the sampling site closest to the summit crater (~1.5 km). In the distal sites (5.5-10 km from the summit) and downwind of the summit craters, the volcanic contribution is also detectable but often overwhelmed by anthropogenic or other natural (seawater spray, geogenic dust) contributions. Volcanic contribution may derive from both dry and wet deposition of gases and aerosols from the volcanic plume, but sometimes also from leaching of freshly emitted volcanic ashes. In fact, in our background site (7.5 km in the upwind direction,) volcanic contribution has been detected only following an ash deposition event.

Fluorine, S and Cl, are the major elements that prevailingly characterize the volcanic contribution in bulk deposition on Mt. Etna, but high concentrations of many trace elements are also detected in the studied samples. In particular, Si, Al, Fe, Ti, Cu, As, Rb, Pb, Tl, Cd, Cr, U and Ag display, in the site most exposed to the volcanic emissions, median concentration values about two orders of magnitude higher than those measured in our background site. Furthermore some of the analysed elements display very high enrichment values with respect to the average crust and, in the closest site to the summit craters, also deposition values higher than those measured in polluted urban or industrial sites.

DISTRIBUTION AND MOBILITY OF AS AND SB IN STREAM WATER, SEDIMENT AND SUSPENDED MATTER IN A FORMER MINING AREA AT GLENDINNING, SOUTHERN SCOTLAND

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The small upland catchment of the Glenshanna Burn at Glendinning (Scottish Borders) was investigated for possible As and Sb contamination derived from long-term antimony smelting and mining activities. The aims were to establish the spatial variation in concentration of As and Sb in water, suspended particulate matter (SPM) and sediment of the river system; to assess the level of contamination, and to estimate the chemical forms of As and Sb and their mobility in the river solids. On the basis of multiple and single chemical extractions, it appears that As and Sb partitioning is highly variable within this river system. Arsenic and Sb in all the compartments studied showed high concentrations (exceeding acceptable guidelines). Arsenic concentrations (as high as 970 μg L^{-1}) in water samples adjacent to mine tailings indicate mobilization of As. Despite the high relative availability of Sb in sediments only two water samples contained detectable Sb levels. The main sink for Sb was the sediment. Speciation, saturation index and solid phase stability for stream-water samples were evaluated using Geochemist Workbench™ and PHREEQC computer programs. It was revealed that both As and Sb undergo precipitation and dissolution in the stream water, their solubility depending mainly upon Fe-Al oxy/hydroxide and calcite dissolution in the water system. The only As and Sb bearing mineral phases supersaturated in the waters were $Ba_3(AsO_4)_2$ and SbO_2 and $Sb(OH)_3$. Principal Component Analysis indicates both geogenic and anthropogenic influences on As and Sb behaviour in the soil-sediment-water system.

IMPACT OF OCCUPATIONAL LEAD EXPOSURE ON INDUSTRIAL WORKERS HEALTH CONDITION; TEHRAN-IRAN

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Continuous occurrence of occupational lead exposure and ultimately lead poisoning remains a serious problem worldwide despite awareness of its adverse health effect. Lead serves no useful biological function in human metabolism. However, human body absorbs and stores it. In the present work Blood lead level (BLL) in a group of 31 male non smoking workers working in different industrial occupations were determined. Then the effect of BLL on hematology parameters (Hgb & Hct), employment , fatigue and bone pain symptom were investigated. Workers Blood lead level (BLL) were determined by a Varian spectra AA-220 equipped with Varian GTA-110 partition graphite tube atomizer. Varian hollow-cathode lead lamp was the light source. The control materials used for the precision and accuracy of the method were Seronorm-whole blood level I & II (Sero AS Asker-Norway). Based on the filled out questionnaire the workers age mean and employment time mean were 38± 8 years and 12±7.0 years respectively. The workers BLL ranged from 15.50 µg/dl to 59.99 µg/dl with mean=34.80±12.90 µg/dl. The Pearson product moment test indicated no correlation between BLL & Hgb (r =-0.09 & p=0.62) and BLL & Hct (r = -0.14 & p=0.46). However, BLL & employment years correlated (r = 0.37 & p= 0.04). To investigate the effect of BLL on fatigue and bone pain reported among workers we used independent t-sample test. The obtained results indicated 23/31 workers with reported fatigue and bone pain had higher BLL than those (8/31) without the symptoms (mean= 38.41µg/dl vs mean= 20.44µg/dl, t= 6.06 ,p=0.00). Furthermore, they had many years of employment (mean=13.4 years vs mean=8.8 years , t= 2.12, p=0.047).

In our study according to completed questionnaires, 74% of the exposed workers complained of fatigue and chronic, mild bone pain. Their BLL was (mean=38.41 µg/dL) and had been employed for mean=13.4 years. It is a difficult task to determine a precise BLL below which symptoms among occupationally exposed workers may occur. However, our preliminary data indicated that occurrence of certain symptoms such as fatigue and chronic bone pain might be associated with lead exposure among industrial workers. Thus in industrial setting we conclude in addition to regular screening, bone lead content measurement by non invasive X-ray fluorescence perhaps is an important way for monitoring the total body lead burden of the exposed workers as well.

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KEYNOTE

MINERAL DUSTS AND DISEASE

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The extraction of minerals from the earths' surface for human use has a history dating back to the stone age. While many extracted materials, particularly metals such as lead and mercury, have been the cause of disease, two are of particular importance: silica and asbestos.

Silica or silicon dioxide is the most abundant compound on the earths' surface and is encountered in mining and quarrying as well as in multiple uses to which silica has been put, such as sand blasting, metal grinding and foundry work. Inhalation of respirable crystalline silica in sufficient amount causes nodular fibrosis of the lungs (silicosis). Respiratory disability and premature death is caused by coalescence of the nodules (conglomerate silicosis) and by tuberculosis, whose incidence is greatly increased in silicosis, a risk further increased in South African gold miners, in whom the prevalence of HIV infection is some 25-30%.

Silica exposure has also been associated with an increased risk of lung cancer, but the evidence is inconsistent. It may also increase the severity of COPD in cigarette smokers.

Asbestos is the name given to fibrous silicates of commercial value. These fall into two major categories – the wavy serpentine fibre, chrysotile (white asbestos) and the long straight fibres, the amphiboles, which include crocidolite (blue asbestos), amosite (brown asbestos) and tremolite.

The commercial exploitation of asbestos took place primarily in the United Kingdom during the first three quarters of the twentieth century. Initially used as an insulating material for high temperature boilers and pipework it subsequently found many additional uses, which included the strengthening of concrete and boarding materials, widely used in the construction industry.

The adverse health hazards of asbestos exposure were suspected in the first quarter of the 20th century, but the first scientific demonstration of pulmonary fibrosis was by Merewether and Price in 1931, of lung cancer by Doll in 1955 and of mesothelioma by Wagner in 1960.

During the last quarter of the 20th century mortality from asbestos and lung cancer associated with asbestos have fallen with improved control of asbestos exposure at work. The incidence of mesothelioma, however, continues to rise with an anticipated peak of between 1950 and 2450 cases between 2011 and 2015. The annual number of deaths in Great Britain has increased from 153 cases in 1968 to 1862 in 2002. Deaths occurring now reflect past industrial exposures; deaths in males aged <45 years have been falling since the early 1990's. An increasing proportion of mesothelioma cases now are occurring in construction workers such as plumbers, carpenters and electricians. In those industries such as shipyards, where control measures were instituted in the 1970's, the incidence of mesothelioma is falling. The beginning of the end of the mesothelioma epidemic is now in view. Although the subject of considerable research, there remains to date no reliable curative treatment for the great majority of cases of mesothelioma.

THE PUBLIC HEALTH SIGNIFICANCE OF ASBESTOS EXPOSURES FROM LARGE SCALE FIRES

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Asbestos is a small group of naturally occurring silicate minerals that can be readily separated into thin fibres that are flexible, very strong and resistant to heat and chemicals. These properties have been recognised for thousands of years. It is only, however, in the relatively recent past that asbestos use, and therefore potential exposure, became widespread. The importation, supply and use of asbestos were banned in the UK in 1999. However, due to its extensive use in the building industry it is still found in many products including: sprayed coatings/lagging, insulating boards, ropes, cloth, millboard, asbestos-cement sheets, coated metal, and textured paints.

Because of its extensive use, large scale fires involving asbestos containing materials (ACM) are relatively common occurrences in the UK and can cause significant public concern. The Health Protection Agency is responsible for ensuring that public health responses to such incidents are appropriate and consistent. It was therefore considered important to investigate the potential public health consequences of such incidents and explore actions that can be taken to minimise their impact. To this end, a systematic literature review was undertaken to identify available information on both the level of asbestos exposures that might result from fires and the potential health impact of such exposures.

The study found that a number of factors mitigate against significant exposures of members of the public following a fire involving ACM. The available evidence indicates that asbestos exposures of members of the public following such fires will be very small if appropriate clean-up operations are undertaken. There is no direct evidence of long-term health risks from fires involving ACM, although the literature in this area is limited. Considering the available evidence on asbestos exposures from fires in the context of the results of epidemiological studies of occupational and environmental asbestos exposures, it is concluded that the risks of long-term health risks (mesothelioma and lung cancer) are minimal if appropriate clean-up occurs. It is recognised that this analysis involves the extrapolation of exposure response models developed from occupational studies of populations exposed for longer periods at significantly higher asbestos concentration levels. However, it is considered that this approach is reasonable and unlikely to underestimate the risks. It is recommended that all Local Authorities have a written policy for dealing with large scale fires involving asbestos.

PROTECTION AGAINST *MALIGNANT MESOTHELIOMA* BY CONSOLIDATION OF ASBESTOS-CONTAINING OUTDATED CONSTRUCTION MATERIALS USING STRAIGHT SILICONE RESIN

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Asbestos has been used to strengthen mortar, slate, construction board and in some other materials like brake shoe of car. It has been used in industrialized nations for long time. Within the last two decades, however, friable asbestos has been regarded to be mineral pollutant that causes *malignant mesothelioma*; this must be terminated immediately. We invented special reagent to prevent flotation of asbestos from outdated sprayed insulation, mortar, slate and some other construction products. Although the special reagent consists of mainly methylphenyl straight silicone oil (Ecobesto, Patent pending), we modified it to highly permeable fluid. The reagent, therefore, is not viscous: its viscosity is approximately one third of water and it can easily penetrate even into slate. We examined its physical and chemical characteristics, and report its significant advantages for consolidation of fragile asbestos-containing construction materials. The fluid solidifies filling vacancies between minerals and entirely covers asbestos fibers. After it solidifies, the fluid becomes simple straight silicone resin in the fragile construction material. We pulverized the Ecobest-treated asbestos-containing construction material smaller than 400-micron meters. Even after the asbestos was pulverized, the straight silicone resin covers asbestos fibers: these can be recognized by a phase contrast optical microscope as well as with an electron microscope. XRD examination can hardly recognize asbestos covered by the straight silicone. This demonstrates that the straight silicone resin has considerably strong affinity with asbestos. Since its strong physical affinity with asbestos, it appears neither friable fiber nor needle that may sting alveolus in lung after treatment by Ecobesto. Although chemical toughness of silicone resin is well-known, acid leaching experiments have been carried out using strong mixed acid. We have shaken Ecobest-treated asbestos with mixed acid solutions (pH=1). One consists of sulfuric acid and nitric acid. Another sulfuric acid, nitric acid and hydrochloric acid. Since the rain in metropolitan Tokyo, Japan is weak acid (pH=4.5), and the annual rainfall amounts to 1500 mm, the acid leaching experiments are analogous to exposure of the asbestos-containing straight silicone to such acid rain for more than 400 years. After the leaching experiment, the samples were dried and prepared for an electron microscope examination and for a phase contrast microscopic observation. The straight silicone resin enveloping asbestos is not dissolved and still covers asbestos fibers. The results demonstrate the straight silicone resin is highly advantageous to prevent asbestos flotation into the air from the outdated fragile construction materials.

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RAMAN MICROSPECTROSCOPY: A POWERFUL TOOL FOR STUDYING ASBESTOS IN BUILDING MATERIALS

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Detecting asbestos in building materials is subject to strict legislation because of the high health risks it poses in its airborne state; hence, more and more analytical techniques such as X-ray Diffraction (XRD) and Scanning and Transmission Electron Microscopy (SEM/TEM) with Energy Dispersion Spectrometry (EDS) have been applied in the study of asbestos mineral phases the last years. Raman microspectroscopy, as a tool for the identification and characterization of the asbestos minerals, has gained ground among the other methods because of its two main advantages, non-destructiveness and easiness. The initial disadvantage of the lack of well-defined spectra references has been almost eliminated by the increasing number of integral studies [e.g. 1,2]. In this study, Raman microspectroscopy is applied for the first time in asbestos minerals of different species from natural rocks and building materials from Greece. Raman spectra were first obtained with a *Renishaw Ramascope RM1000* excited with the 632.8nm line of an He-Ne laser at the School of Mining and Metallurgical Engineering of the Technical University of Athens. Then, Raman analyses were subsequently performed with a *Kaiser RXN1 Analyzer* portable Raman microspectrometer equipped with two-wavelength excitation lasers (at 532nm and 785nm) at the Institute of Geology and Mineral Exploration. Raman results were combined with SEM/EDS data for a better characterization of the asbestos minerals. Raman peaks diagnostic of actinolite- tremolite- chrysotile- and crocidolite- asbestos appear in the spectra along with those of other coexisting phases (e.g. calcite). The presence of asbestos minerals was confirmed in cement-asbestos in chimneys and elenit-sheet roofs, as well as in other building materials as plastic floor tiles and asbestos-fabrics. In natural rocks, asbestos minerals were found mainly in green stones. Problems aroused occasionally by high fluorescence background in some spectra were solved by using another excitation source. As it comes out Raman microspectroscopy is a powerful tool for studying asbestos in natural rocks and building materials. Portable Raman microspectroscopy although lower in resolution also provides well-defined spectra and can be used for *in-situ* detecting and characterizing asbestos in building materials.

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GARDEN SOIL AND HOUSE DUST AS EXPOSURE MEDIA FOR LEAD UPTAKE IN THE MINING VILLAGE OF STRATONI, NORTH GREECE

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Ingestion and inhalation of solid phases containing metals are major exposure pathways to humans. This holds especially in mining and ore processing areas where effective redistribution of metals occurs in the surface environment as a result of natural weathering processes as well as human activities. It is also widely accepted that apart of the total concentration, the chemical and physical aspects that define speciation of a metal control its reactivity, including its solubility and uptake behaviour. Thus, thorough geochemical and mineralogical characterisation of the solid material can provide valuable data on the mobility of potentially toxic elements and constrain pathways of exposure.

This study presents the relationships between two exposure media (garden soil and house dust) for Pb uptake in Stratoni village, an industrial area of mining and processing of sulphide ore in north Greece. Lead data from the two media are compared in terms of bulk sample composition, measurement and geochemical variability, operationally defined phases content through a selective extraction scheme, mineralogical composition, and grainsize distribution. It was found that total Pb is enriched in house dust samples by a factor of 2 on average. Total Pb concentration in soil samples has a maximum of 2040 μg g^{-1} and reaches a maximum of 7000 μg g^{-1} in house dust. The estimated variability due to measurement uncertainty is dominated by the sampling process (22% of the total for dust samples and 15 % of the total for soil samples) highlighting the high degree of heterogeneity in both media in respect with Pb concentration. Significant differences were observed in mineralogical composition of outdoors soil and indoors dust. Lead enriched Fe and Mn oxides predominate in soil samples while very fine galena grains (10 μm – 20 μm diameter) is the major Pb bearing phase in dust samples.

The results underline the importance of house dust for risk assessment and highlight the effect of outdoors and indoors conditions on the fate of Pb in the particular environment of Stratoni.

USE OF LOCAL MORAN'S I AND GIS TO IDENTIFY POLLUTION HOTSPOTS OF PB IN URBAN SOILS OF GALWAY, IRELAND

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Pollution hotspots in urban soils need to be identified for better environmental management. It is important to know if there are hotspots and if the hotspots are statistically significant. In this study identification of pollution hotspots was investigated using Pb concentrations in urban soils of Galway City in Ireland as an example, and the influencing factors on results of hotspot identification were investigated. It was found that the index of local Moran's I was a useful tool to identify pollution hotspots of Pb pollution in urban soils, and to classify hotpots into spatial clusters and spatial outliers. However, the results were affected by definition of weight function, data transformation and existence of extreme values. While it is hard to decide the best way of using this index, it is suggested that all these influencing factors should be considered until reasonable and reliable results are obtained. GIS mapping can be applied to help evaluate the results via visualization of the spatial patterns. Meanwhile, selected pollution hotspots (extreme values) in this study were confirmed by re-analyses and re-sampling.

GOLF COURSES – HAZARDS TO HEALTH?

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Golfing has become an activity widely enjoyed. Many new courses have been built in the UK and elsewhere. Golf courses are sometimes built on contaminated land, giving rise at times to a variety of public health questions and concerns.

From three such golf courses that our Health Protection Unit has been involved with we have identified points of interest to health professionals and environmental scientists:

- The historical uses of such sites before becoming a golf course
- The hazardous nature and levels of the contaminating chemicals
- Exposure pathways to the local community
- Public anxiety about the site and its perceived consequences on health
- Alleged clusters of disease, especially cancers
- Particular problems associated with large or small numbers of users, staff, or other exposed populations, including vulnerable groups such as children
- The need to balance health effects including exercise, quality of life and amenity, *versus* anxiety and potential / actual exposure to toxins
- The interaction of various agencies and communities seeking to improve and protect Public Health
- Communications strategies, with stakeholders and media interest

(Not all of these are applicable to each site.)

We illustrate this using one site as a case study, including:

- The soil contamination to light during investigation into groundwater pollution
- A differing history of remediation on the two parts of the course had led to thick and thin clay caps
- High levels of arsenic were found across the soil over the thinner clay cap
- One ‘hot spot’ had particularly high arsenic levels
- A multi-agency Health Advisory Group (health organisations, local government, Environment Agency, environmental contractors) met to discuss the situation and devise an action plan
- Risk characterisation and calculations showed the greatest health risk was to youth who used the site to meet, not to small children walking on the site nor to golfers playing regularly.
- More detailed epidemiological investigations were considered unlikely to be productive, given their logistical complexity and low likelihood of further useful evidence.

BASELINE GEOCHEMICAL CHARACTERISTICS OF URBAN AREAS - A RECORD OF ENVIRONMENTAL CHANGE IN THE ENGLISH MIDLANDS

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Systematic baseline sampling of soils in urban and rural areas has been undertaken by the British Geological Survey's (BGS) Geochemical Baseline Survey of the Environment (G-BASE). Using these urban and rural data in conjunction with each other provides a more powerful, and useful, interpretation of urban soil quality data to be made. In particular, this is because it allows the calculation of the unimpacted baseline concentration range, from which the effect and extent of urban activity on these baseline conditions can be assessed. Such an analysis provides a valuable tool for communicating to users the change which has occurred in the soil environment, generally within the last few hundred years of urbanisation and industrialisation.

These approaches have been undertaken using both urban and rural soil data from the English Midlands; an area in which the cities have differing histories of industrialisation and urbanisation, and are situated over contrasting soil parent materials. The interaction of these factors has led to varying enrichments of those contaminants which are widely reported in urban studies (e.g. Pb), some which were less expected (e.g. Br), and those which are elevated due to geogenic sources (e.g. As in Northampton). The possibility of a natural source for 'contamination' such as this is an important factor, and one which is sometimes overlooked in studies focusing only on the city area. The degree of anthropogenically driven environmental change has been examined by comparison of data from urban and non-urban areas overlying the same parent materials. Estimates have been made of the extent of this change in soil composition, using simple calculations based on exploratory data analysis,and probability plots.

ARSENIC BASELINE CONCENTRATIONS IN SURFACE SOILS OF THE KAVALA AREA, NORTHERN GREECE

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Potentially toxic trace elements are considered to be one of the main sources of contamination, mainly because of human activities such as industry and agriculture, which mobilize and redistribute these elements, often causing adverse effects. The study of the distribution of trace elements in soils is very important because they are considered as the principal sinks for these elements and ideal means for monitoring contamination. The main industrial activities in the study area are the Phosphoric Fertilizer Industry (P.F.I.) and the Kavala Oil land facilities, while agricultural activities are common in the area, as well. A total of 65 uncultivated surface soil samples in the Kavala area were collected and an effort to estimate arsenic's baseline values in the study area was made. In past and recent years arsenic has raised a lot of attention since it is considered highly toxic and a class A carcinogen. Arsenic was extracted by using analytical reagent grade nitric acid and its concentrations were determined in all samples by Inductively Coupled Plasma –Mass Spectrometry (ICP–MS). The concentration values of arsenic were log-transformed so they would follow the normal distribution and log-normal probability plots were generated. After the exclusion of extreme values the arsenic geochemical baseline values were calculated as the values that lie between x/g and x*g (where: x, geometrical mean and g, geometrical standard deviation), which are 3.5 mg kg^{-1} and 25.8 mg kg^{-1}, respectively. Apart from the arsenic baseline values four other groups of arsenic concentrations were calculated and defined as: negative anomaly or depletion [As]<(x/g), being x/g=1.37 mg kg^{-1}, possible anomaly between (x*g) and ($x*g^2$), being ($x*g^2$)=70.31 mg kg^{-1}, probable anomaly between ($x*g^2$) and ($x*g^3$), being ($x*g^3$)=191.43 mg kg^{-1}, and certain anomaly ([As]>($x*g^3$)). After the creation of a GIS, which included map layers with the main industrial activities of the study area, the arsenic concentration values (divided into the 5 aforementioned groups) and the known PBG sulphide occurrences in the study area, a connection between the elevated arsenic values and the industrial activities seems likely, since most of these values are found near the area where the industrial activities take place. However, a possible contribution from the widespread PBG sulphide occurrences and the parent rocks of the area cannot be ruled out.

KEYNOTE
MEDICAL GEOLOGY – AN INTERNATIONAL OPPORTUNITY FOR THE FUTURE

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Medical geology is the science dealing with the influence of geology on the distribution of health in humans and animals. This is a complicated subject and interdisciplinary contributions from essentially different scientific fields are required when these problems are to be solved. This lecture discusses the background of medical geology with examples from all over the world. All living organisms, are composed of major, minor and trace elements, given by nature and supplied by geology. Medical Geology is a rapidly growing discipline that has the potential of helping medical and public health communities all over the world pursue a wide range of environmental and naturally induced health issues. Medical Geology is a rapidly growing field which brings together geoscientists and medical/public health researchers to address health problems caused, or exacerbated by geological materials (rocks, minerals, atmospheric dust and water) and processes (including volcanic eruptions and earthquakes. Among the environmental health problems that geoscentists are working on in collaboration with the medical and public health community are: exposure to toxic levels of trace essential and non-essential elements such as arsenic and mercury; trace element deficiencies; exposure to natural dusts and to radioactivity; naturally occurring organic compounds in drinking water; volcanic emissions, etc.. Medical geology also deals with the many health benefits of geologic materials and processes.

Practitioners of Medical Geology have five principal goals

(1) To identify anomalies in soils, sediments, and water that may impact human and animal health;
(2) To identify the environmental causes of known health problems and, in collaboration with biomedical/ public health researchers, seek solutions to prevent or minimize these problems;
(3) To evaluate the beneficial health effects of geologic materials and process;
(4) To reassure the public when there are unwarranted environmental health concerns associated with geological materials or processes, and
(5) To forge links between developed and developing countries to find solutions for environmental health problems.

Medical geology is involved in promoting medical geology at meetings around the world by organizing and/or sponsoring special sessions or symposia on medical geology and also provided financial support for students and professionals from developing countries to participate. Short courses have been presented in almost 40 countries and have been attended by thousands of students and professionals with backgrounds in geoscience, biomedical/public health science, environmental science, geography, engineering, chemistry, etc. In addition, local scientists are invited to describe medical geology work going on in their regions. We have produced a CD containing the lecture materials used in the short course as well as supplementary material. It is encouraged that this material will be used by participants to conduct their own courses in medical geology.

The Swedish Royal Academy of Sciences was the venue for one of the most recent International Symposium on Medical Geology which was organized in May 2006 under the auspices of the Academy. The activity was able to bring together over 100 scientists from all over the world to discuss the state of medical geology and future directions.

In 2005 Elsevier published *Essentials of Medical Geology* edited by Olle Selinus and six associate editors. *Essentials of Medical Geology* contains contributions from over 60 distinguished authors from around the world. About 50% are geoscientists and about 50% are medics, veterinarians and other scientists. The book contains more than 800 pages with illustrations in full color. The book has been awarded several prizes from both medical and geological organisations as one of the best books published in these fields in the world during that period.

As a recent step in the development of medical geology the International Medical Geology Association (IMGA) was established in January 2006**.** Information can be found on the website http://www.medicalgeology.org. IMGA has organised itself in regional divisions all over the world and also chapters in several countries. Regular conferences have started, e.g. hemispheric conferences in South-Central America. IMGA is also active in organising several symposias and other meetings at 33rd IGC in Oslo in August.

HIDDEN THREAT: GROUNDWATER POLLUTION AND HEALTH RISKS ASSOCIATED WITH MIDDLE DEVONIAN, ORGANIC-CARBON-RICH, BLACK SHALES IN SOUTHERN VIRGINIA, U.S.A.

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As in many sedimentary terrains across the globe, black shales are a ubiquitous lithotype within the southern Appalachian mountains in the Eastern United States and in Southwestern Virginia. Such shales in the Appalachian Basin have been extensively studied for hydrocarbon production and recovery. However, little is known concerning their role in and mechanism(s) for generation of acid mine drainage (AMD) and related health risks. This paper will present the results of research aimed at 1). Evaluating the stratigraphic distribution of the Middle Devonian, Millboro and Needmore Black Shales within Virginia, 2) Determining the modes of occurrence of polymetallic, sulfide complexes (primarily pyrite) at a microscopic and electron microscopic scales, and 3) Creating a model for oxidative weathering of such pyritiferous phases as it pertains to generation of sulfuric acid and contamination of local groundwater.A total of 200 black shale samples were analyzed for their mineralogy and geochemistry at both the macroscopic and microscopic scales using the research lab facilities at Radford University and Virginia Tech. Polished slabs were made for the samples exhibiting bioturbation and examined under reflected light microscopy to determine the relationship between benthic animal activity in the paleoenvironment and differential preservation of pyrite in such rocks. Further, high-magnification image analysis was done to quantify the levels of bioturbation in samples and correlated to the degree of pyritization in such samples.

Results, to date, reveal that both the darker, black, organic-carbon-rich, Millboro Shale samples, as well as the lighter-colored, less-organic-rich, and more bioturbated Needmore Shale samples, contain significant amounts of pyritiferous mineral assemblages - the oxidation of which is responsible for creating AMD conditions in the local groundwater supply and associated health risks. Surprisingly, however, SEM and BSEM analyses of the Needmore Shale samples show that despite the high levels of bioturbation, organic matter preservation still caused high amounts of pyritiferous phases to be formed. The notable difference between the morphology of pyritiferous phases between the two shale types was that the sulfidic minerals in the gray Needmore Shale were framboidal and much more finely-dispersed/disseminated (micron-scale) in comparison to the Millboro Shale [wherein the sulfidic minerals were much more localized but significantly larger in size (cm-scale)]. Results highlight the importance of studying the more bioturbated, less-organic-carbon-rich, gray shales for their polymetallic sulfide mineralogy – something that has been hitherto largely ignored by shale geochemists. It is hoped that geochemists from other parts of the world will take notice of the possibility of groundwater contamination associated with such seemingly innocuous lithologies and the hidden threat they pose to animal and plant species.

TREATMENT FOR REUSE OF GREYWATER AND THE ELIMINATION OF ASSOCIATED HEALTH RISKS

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South Africa is a water-stressed country in which the rainfall is unevenly distributed. The growing population and increased industrial output have put the drinking/potable water resources under pressure. Alternative sources of water have been sought to replace drinking/potable water in operations such as irrigation and toilet flushing. Greywater is a domestic wastewater without any input from the toilets, and accounts for 60-70 % of the daily volume of domestic sewage. It carries finite concentrations of nutrients, but also contains significant levels of potential pathogens from faecal cross-contamination. That means that greywater could provide a suitable medium for irrigation, because of the contained nutrients such as nitrogen and phosphorus, however, the associated health risks have to be eliminated first. In South Africa, data on the composition of greywater, and quantification of the potential health risks are lacking in literature. To fill this gap we have conducted a study on the characterization of greywater from Grahamstown (RSA). At the same time, we investigated the effciency of a low-cost treatment system with respect to the reduction of selected chemical and microbiological indicators. Samples of greywater were collected on the campus of Rhodes University, and the mulch tower (MT) system for greywater treatment was composed of mulch, coarse sand, fine and coarse gravel layers. Analyses were conducted for the following parameters: COD, BOD_5, total suspended solids, pH, temperatures, alkalinity, total hardness, concentrations of NH_4^+-N, NO_3^--N, PO_4^{3-}-P, SO_4^{2-}, S^{2-}. The values measured were comparable to the literature values measured in the USA, Europe and Australia. The MT system proved efficient in the reduction of COD, total suspended solids, NO_3^--N and S^{2-}. Health risks from greywater were assessed by measuring the concentrations of indicator organisms. The faecal coliform concentration values were higher than 6.6×10^6 CFU/100 cm^3, while the total coliform concentrations were higher 1.7×10^6 CFU/100 cm^3. The MT effluent did not meet hygienic norms for irrigation water with respect to the concentration of indicator organisms. Therefore chlorination of the MT effluent with a mixture of sodium dichloroisocyanurate and trichloroisocyanuric acid was investigated as a method for the elimination of potential pathogens. A continous-release dosage form led to a decrease in the faecal and total coliform concentrations below 800 CFUs/100ml within 65 hours, i.e. thus making the final effluent suitable for irrigation purposes. After this time, the pH of the effluent became too acidic for pumping operations. Analysis of potential disinfection by-products did not show the presence of chloroform, but presence of haloacetic acids was indicated. Potential hazards are estimated and solutions proposed.

PURIFICATION OF URBAN WASTEWATERS, PRODUCTION OF ODORLESS ZEO-SEWAGE SLUDGE AND FOOD QUALITY IMPROVEMENT, USING HELLENIC NATURAL ZEOLITE

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Hellenic Natural Zeolite (HENAZE) from specific area of Petrota (Evros Prefecture, Northeastern Greece), contains 89 wt.% (Ca,K,Mg,Na)-Clinoptilolite, shows a remarkable high ion exchange capacity of 226 meq/100g and regulates to the neutral the pH of waters. The mineralogical composition and the physico-chemical properties make the HENAZE suitable material for numerous industrial, agricultural (soil cultivation and animal feeding) and environmental applications.

The treatment of Kilkis city urban wastewaters with the HENAZE, reduces the initial pH of 8.2 to 7.3, produces clear water and as precipitate, odorless-cohesive zeo-sewage sludge suitable for safe deposition. The produced clear water is odorless and improved in color, suspended particles, P_2O_5, COD and NH_4 contents by 94.1-99.4%. The final pH value and the above mentioned parameters for the produced clear water, are fulfilling the requirements for disposition as downstream, irrigation, swimming and fish waters.

The addition of HENAZE in the agricultural soils: a) improves the root-system of the plants, b) increases the production of maize by 50% and of tomato by 52%, c) improves the quality characteristics of tomato by 4% for soluble solids, 26% for vitamin C and 46% for the firmness, d) reduces the use of fertilizers by 100% in maize cultivations, e) reduces the usage of irrigation water by 67% for zero production-increase and 33% for production-increase of maize by 50%. The odorless and cohesive zeo-sewage sludge, produced either from the urban wastewaters treatment or from the mixing of HENAZE by sewage sludge, can be used for the reclamation of agricultural soils.

The addition of the odorless-cohesive sewage sludge, but also the exclusive addition of the HENAZE, as fertilizer in the agricultural soils, prevents the seepage of dangerous substances into the water environment, reduces the eutrophication problem of waters, protects the quality of surface and underground waters, reduces the irrigations, improves the quality and the production of agricultural products and thereupon effects positively the people's health.

MOLECULAR INDICATORS FOR POLLUTION SOURCE IDENTIFICATION IN MARINE AND TERRESTRIAL WATER OF THE INDUSTRIAL AREA OF KAVALA CITY, NORTH GREECE

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Marine and terrestrial surface waters act as recipients of a significant part of pollution created by human activities. The most obvious path of pollutants entering the water bodies is their direct offload with liquid or solid wastes. Especially in coastal areas, the direct discharge of industrial or domestic wastes is very common and, as a consequence, the resulting water pollution can cause serious disturbance of the affected aquatic ecosystem as well as public health problems. Apart from the direct path, many compounds enter the aquatic system by wet or dry atmospheric condensation or by surface run off.

Eight terrestrial and four marine water samples were collected from the coastal industrial section of the city of Kavala in Northern Greece which is suspected to be influenced by several types of anthropogenic activities e.g. a petrochemical industry, a fertilizer industry, agriculture, etc. These activities generate emissions that have led to a possible damage to the aquatic ecosystem of this zone. Therefore, it is necessary to understand the full extent of contamination in order to determine possible long-term detrimental effects to the environment, to the people nearby, etc.

Aim of this study is to determine the state of the organic pollution in this zone, to discuss the occurrence and spatial distribution of individual organic contaminants, as well as to identify the molecular markers of different emission sources.

The water samples collected from this area have been retrieved and extracted with organic solvents. The extracts have been investigated qualitatively and quantitatively by a non-target screening approach based on gas-chromatography-mass spectrometry.

Very detailed organic-geochemical investigation revealed a wide variety of compounds including organohalogen compounds, technical additives and their metabolites, organophosphates, phthalates, benzothiazoles, etc. Further on, besides well documented contaminants, the investigation revealed several rarely described or even unknown compounds which could be clearly allocated to anthropogenic origin due to their structural properties. Quantitative results enabled a comparison of the anthropogenic impact with respect to the marine and terrestrial environment. Analysis of the xenobiotics' occurrence pattern exposed immission hot spots. Generally, this coastal area can be characterized as strongly effected zone by anthropogenic activities.

EVALUATION OF METAL CONCENTRATIONS IN GROUNDWATER NEARBY SOMA COAL-FIRED POWER PLANT, TURKEY

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Groundwater pollution by metals nearby Soma coal-fired power plant in Turkey was investigated to assess the effect of ash disposal on groundwater. Coal combustion results in huge ash piles from which metals can originate and migrate to groundwater. Forty samples were collected from forty water wells nearby the power plant to determine fourteen metals namely, Na, Ca, K, Mg, Al, Ba, Fe, Zn, Cu, Pb, Cr, Cd, Ni, and V. The results were compared with the World Health Organization, the European Community and the Turkish Guidelines for drinking water quality. Iron and zinc concentrations in 5 wells were higher than the EC guidelines. Lead concentrations were less than the three guidelines but were relatively high in 8 wells. The other anthropogenic elements were lower than the three guidelines. Some toxic elements concentrations like lead did not exceed the guidelines, but these metals tend to accumulate and if no action is taken for the disposal of ash, these metals will exceed the guidelines with time.

Soma city residents are at risk because they drink the groundwater and use it for irrigation. This water is polluted with Fe and Zn and there are some amounts of the other metals which will accumulate over time. So, correction steps should be taken to overcome the problem of the ash disposal and save the health of the residents.

THE SPATIAL AND TEMPORAL DISTRIBUTION OF HEAVY METALS IN SEDIMENTS OF VICTORIA HARBOUR, HONG KONG

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Victoria harbour has received substantial loadings of pollutants from industrial and municipal wastewater discharged since the 1950s. Inputs of contaminants have declined dramatically during the last two decades as a result of better controls at the source and improved wastewater treatment facilities. To assess the spatial and temporal changes of metal contaminants in sediments in Victoria harbour, core and grab sediments were collected. The central harbour areas were generally contaminated with heavy metals. The spatial distribution of trace metals can probably be attributed to the proximity of major urban and industrial discharge points, and to the effect of tidal flushing in the harbour. In the sediment cores, the highest concentrations of trace metals were observed to have accumulated during the 1950s to 1980s, corresponding with the period of rapid urban and industrial development in Hong Kong. From the late 1980s, there has been a major decline in the concentrations of trace metals, due to a reduction in industrial activities and to the enactment of wastewater pollution controls in the territory. The Pb isotopic compositions of the sediments revealed the anthropogenic inputs of Pb to the harbour. The $^{206}Pb/^{207}Pb$ ratios varied from 1.154 to 1.197, which were lower than those of background geological materials in Hong Kong ($^{206}Pb/^{207}Pb$: 1.201–1.279). The data also indicated that the Pb in the harbour sediments most likely originated from mixed sources, including the leaded gasoline used in the past and other anthropogenic sources.

CHEMICAL PROFILE OF LEBANON'S POTENTIAL CONTAMINATED COASTAL WATER

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Lebanon is a small Mediterranean country noted for its coastal zone. It is characterized by its busy transport-export-transit services, which constitute the backbone of its socio-economic development. Besides, it is an attractive site for tourism that contributes in the development and growth of the country. However, Lebanese marine water is exposed to major point source contaminants such as sewage outfalls, industrial waste water, and coastal agricultural runoff and leachate from seafront dump, rendering the quality of its water and posing public health threats. Assessing the type and magnitude of these threats is critical for developing proper integrated interventions essential to protect the ecological marine water and general public health. Risk assessment associated with deteriorative water quality profile is affected not only by the quantities of specific contaminant disposed, but is highly dependent on its chemical speciated forms. The objective of this study is to quantify and analyze the Lebanese chemical marine water profile. Sea water samples were collected based on GIS map of all types of discharged zones along the coastal line. The chemical water quality was assed by measuring the following parameters: temperature, pH, dissolved oxygen, alkalinity, chloride, nitrate, sulphate, phosphate, Na, K, Ca, Mg, Ba, Sr, Bi, Al, Fe, Mn, Cu, Zn, Sb, Sn, Pb, Cd, Ni, Co, V, As, Hg and U. Whereas, the microbiological profile was assed by detecting faecal coliform in water samples. Results showed contamination by faecal coliform in most samples. In addition, high levels of toxic trace metals were detected. However, the actual projected impact of the detected metals on human health were assessed using geochemical models "FREEQCE" and "Mineq+" that predict the metal species forms and where the most toxic specie form is the free aqua-metal ion. In conclusion, results from this study necessitate the proposal of an integrated intervention plans for the protection of this marine source to preserve the ecological marine water and general public health and be in line with international treaties governing this sector.

Acknowledgement: This study was supported by the University Research Council, Lebanese American University under contract #s (URC-c2006-02 and URC-F2006-21) and the Lebanese National Council for scientific Research (CNRSL)

OXIDATIVE STRESS BIOMARKERS IN GREY MULLET (*MUGIL CEPHALUS)* FROM POLLUTED GREEK COASTAL WATERS

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A wide range of pollutants including organic xenobiotics and metals may enhance production of reactive oxygen species (ROS) in marine organisms leading to changes in the antioxidant defence system and oxidative damage of cellular constituents. Enzymes of the antioxidant defence system can be induced by enhanced production of ROS as a protection mechanism against oxidative stress or inhibited when deficiency of the system occurs predicting toxicity. Thus antioxidant enzyme activities and oxidative damage of macromolecules can be used as biomarkers of pollutant-mediated oxidative stress. This study aimed to assess oxidative stress biomarker responses to pollution in grey mullet (*Mugil cephalus*), a species widespread in Greek coastal waters. Fish were collected from two polluted sites (Perama bay, Saronikos Gulf and Larymna bay, N. Evoikos Gulf) and a reference site (Anavyssos, Saronikos Gulf) during three samplings in 2006-2007. Perama bay borders the heavily industrialized area of Elefsis bay (oil refineries, shipyards, steelworks etc) and the port of Pireaus, Larymna bay is adjacent to a ferro-nickel smelting plant, while the reference site, Anavyssos, is located far from industrial activities. Activities of four antioxidant enzymes i.e. catalase, Se-dependent glutathione peroxidase, total glutathione peroxidase, glutathione-S-transferase, and lipid peroxidation (measured as thiobarbituric acid reactive substances) representing oxidative damage were measured in the liver of the fish. Antioxidant enzymes activities were significantly reduced in fish from the polluted sites (Perama bay, Larymna bay) compared to fish from the reference site (Anavyssos). Lipid peroxidation was markedly increased in fish from Perama bay compared to Anavyssos in two of the samplings. Results indicate inhibition of antioxidant enzyme activities at the polluted sites suggesting deficiency of the antioxidant system to compensate to oxidative stress. This is further supported by the observed increases in lipid peroxidation representing oxidative damage.

This study, which is the first measuring biomarkers in fish in greek coastal waters, showed pollution induced oxidative stress responses in grey mullet and suggests that these responses can be used as biomarkers for the assessment of pollution in coastal environments.

BIOMARKER OIL-OIL CORRELATION OF NARGESI OILFIELD AND OIL SEEPS IN DALAKI REGION, SOUTH IRAN

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In the Zagros Basin (South Dezful Embayment), the oil seeps has been recognized in Dalaki area near Nargesi oilfield. In order to inject gas in the Nargesi Oilfield, and at the same time prevent environmental hazards it is necessary to establish the origin of oil seeps and crude oils.

In this study, oil seeps and oil reservoir samples were analyzed by GC and GC/MS with the aim to identify source facies and the genetic relationship between Asmari/Jahrom reservoir oils and oil seeps in Dalaki area.

The oil seeps and oil samples have been investigated using biomarkers to determine oil-oil correlations. The oil seeps exhibit evidences of biodegradation and mix kerogens, this explains the low saturate fraction (29-38 %), the aromatic-asphaltic nature of the oil seeps and an important depletion in the homohopane series.

The oil seeps are characterized by high predominance C_{29} to C_{30} hopane ratios (1.25-1.8), low ratios of C_{34} over C_{35} (1.42-1.62), and the low diasterane abundance (C_{27}-C_{29}Dia/Reg Steranes: 0.33-0.44). These characteristics suggest that the oil seeps originate from carbonate marine source rocks. On the other hand the reservoir oil samples are characterized by high contents of saturates, Pr/Ph ratios below 2, the dominance of C_{30} hopanes over the C_{29} hopane ($C_{29}/C_{30}<1$), low ratios of C_{34}/C_{35} (1.02-1.4) homohopanes and diasteranes are more abundant. These properties suggest that the oils were generated mainly from marine shale facies. Both oils and oil seeps contain significant amounts of tricyclic terpanes (C_{19}-C_{26}), characteristic enrichment of the C_{23} and C_{24} homologues, typically associated with their marine origin. The C_{29}/C_{30} hopane and Dia/Reg sterane ratios and a relatively high abundance of oleanane in the oil seepages gives the best evidence of different source rocks for oil and oil seep samples. This is also supported with thermal maturity parameters such as $\beta\beta/(\alpha\alpha+\beta\beta)$ sterane and T_s/T_m ratios. Asmari oils are characterized by the following ratios: $C_{29}\beta\beta/(\alpha\alpha+\beta\beta)$ between 0.52 and 1.62, C_{29}20S/(20S+20R) with an average 0.45, T_s/T_m ratios ranging between 0.47 and 1, where as in the oil seeps the ratios are: $C_{29}\beta\beta/(\alpha\alpha+\beta\beta)$ between 1.37 and 1.8, C_{29}20S/(20S+20R) between 0.45 and 0.51, T_s/T_m ratios around 1.87, and even-to-odd carbon preference ranging from C_{14}-C_{26}. All of these conclude that thermal maturity of Dalaki oil seeps is higher in compare to Asmari oils from Nargesi oilfield. The discrepancy in the biomarker indicators gives the assurance of diverse origin of oils from reservoir and from Seepages. Finally the constant seepage discharge even after gas injection into the reservoir proved the oil correlation to be very reliable and trustworthy.

LAVREOTIKI-LAVRION EXCURSION: AN INTRODUCTION TO THE ENVIRONMENTAL AND HEALTH RISKS OF THE AREA

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Lavreotiki is the peninsula to the south-east of Athena, the capital of Hellas, and Lavrion the town, which was the centre of all metallurgical activities during the 19th and 20th centuries. Exploitation of argentiferous galena dates back to *ca*. 3500 BC, with a production peak during the 5th century BC, the "*Golden Age of Athena* or *Pericles*".

The total tonnage of Pb metal, produced from the exploitation of ore from the Lavreotiki peninsula, has been estimated to about 2,260,000 tonnes, out of which 1,400,000 tonnes in ancient times, and 860,000 tonnes during the 19th and 20th centuries. The ancient Hellenes produced also about 3,500,000 kg of Ag, and the modern exploiters *ca*. 1,000,000 kg Ag. These metal tonnages classify Lavreotiki among the giant ore deposits.

A conservative estimate of excavated material, during ancient times, is *ca*. 13,000,000 tonnes. Whereas a very moderate estimate of excavated material in the 19th and 20th centuries is *ca*. 30,000,000 tonnes. This large volume of wastes is exposed to the processes of weathering, erosion and deposition. Their torrential and wind borne transportation resulted in the contamination of soil over almost the whole Lavreotiki peninsula. About 95% of the 170 km^2 surface soil studied (0-10 cm) has Pb contents >110 mg/kg. Soil is also contaminated to a variable areal extent by As, Cd, Cu, Sb, Zn.

The Lavrion urban and suburban area (*ca*. 7 km^2), as the centre of recent metallurgical activities, may be considered an enormous '*waste dump*' of all types of processing wastes, *i.e.*, slag, flotation tailings and pyrite. The surface soil (0-5 cm) is highly contaminated, since there are no values below 810 mg/kg Pb (n=224), with a median value of 7,305 mg/kg (range: 810-151,579 mg/kg). To appreciate the seriousness of the hazardous conditions, the concentrations of Pb in house dust vary from 488 to 18,617 mg/kg with a median of 3,091 mg/kg (n=127). The consequence is that child blood has Pb levels ranging from 5.98 to 60.49 μg/100 ml with a median of 17.83 μg/100 ml (n=235). Over 90% of the children have blood Pb levels >10 μg/100 ml (WHO limit). According to medical studies the children have, among other health related problems, lower composite mental functions (low I.Q.), and reduced development, especially with respect to the circumference of their head and chest.

The first environmental geochemistry study of the Lavreotiki-Lavrion area (1991-1994) was funded by the Regional Funds Programme of Attiki Region (202.088.00), and the second '*Soil Rehabilitation in the Municipality of Lavrion*' (1994-1999) by the LIFE programme (93/GR/A14/GR/4576). The latter was a detailed study of the Lavrion urban and suburban area (7 km^2), which ended with the submission of an integrated environmental management scheme for blocks of land of 50 x 50 m. Since, the submission of the six volume final report, no action has been taken by the relevant authorities, including the Municipality of Lavrion itself.

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- Lavrion case study
- EuroGeoSurveys Geochemical Atlas of Europe
- EuroGeoSurveys Geochemistry Working Group

THE INFLUENCE OF THE ENVIRONMENTAL IMPAIRMENT IN INDUSTRIALIZED AREAS TO THE APPEARANCE OF NEUROLOGICAL DISEASES

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Aim of the Study:

The aim of this study is to examine the possible correlation between, the illnesses recorded in the population of Greek Industrial areas as Larymna and Lavrio and the environmental pollution effected as a result of the emission of particles from the heavy industries operating in the area, the mines, well as the dense circulation of vehicles on the National High speed Motor way connecting Athens to the North part of Greece.

Methods:

This study has been done by recording the medical data of National Health System (Hospitals, Medical Centers of the areas).

The recording diseases are neurological (Polyneuropathies, Panecephalitis, Multiple Sclerosis, Amyotrophic Lateral Sclerosis (ALS), e.t.c

It has been examined the use of fuel in these industries as well as the possibility of using c alternative forms of fuel.

Finally it proposes methods of overcoming the problems while making an attempt to assess the financial burden associated with fighting these pollutants.

QUANTIFICATION METHODS OF ASBESTOS FIBRES IN OPHIOLITIC ROCKS USED AS AGGREGATES AND HAZARD RISK ASSESSMENT FOR HUMAN HEALTH

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Asbestos is a general commercial term used to describe a group of non-metallic, fibrous minerals, which include the asbestiform varieties of actinolite, tremolite, anthophyllite, amosite, crocidolite and chrysotile that have been recognized as a health hazard. Rocks which contain significant amounts of any of these minerals are not suitable for the production of aggregates, since fibres may be released into the air becoming dangerous for public health. The fibres may be easily inhaled and cause serious health problems, including asbestosis, lung cancer, mesothelioma and various cancers of digestive tract. In this study, the proportions of asbestiform minerals were determined in basic and ultrabasic rock samples collected from various ophiolite suites of central and northern Greece. A combination of different methods was used for the detailed investigation of the samples, conducted in the following stages: (i) petrographic examination of thin sections with a polarizing microscope and quantification of the mineralogical composition using a point-counting system, (ii) semi-quantitative mineral phase analysis using X-ray diffraction (XRD), (iii) determination of the fibrous mineral composition on polished thin sections using scanning electron microscopy (SEM), (iv) analysis of back-scattered electron images and secondary electron images using an image-analysing system, to automatically measure the dimensions of fibres and define the percentages of the dangerous asbestiform crystals. The images were acquired from the whole surface of the thin sections, at various magnifications and the results were statistically analysed. Basic rocks contain significant amounts of actinolite, however not all crystals comprise asbestiform fibres; hence XRD patterns are not diagnostic for quantification of asbestos. On the other hand, using optical microscopy two types of actinolite crystals can be detected according to their crystal habit: asbestiform and non-asbestiform; but the percentage of the measured dangerous fibres may be underestimated, due to the existence of extremely fine, undetectable crystals. SEM is a powerful tool for detailed investigation of fibrous minerals. A conspicuous feature observed during careful petrographic analysis is that many of the non-asbestiform actinolite crystals are broken up along their cleavage planes. Rocks with such features need specific consideration since these crystals may subsequently release numerous fibrous crystals, during in-service deterioration of aggregates, increasing their amount relative to that initially measured. On the other hand, serpentinized ultrabasic rocks contain various amounts of asbestiform chrysotile, which becomes identifiable only in secondary electron images.

SECONDARY SULPHATE AEROSOLS IN AN INDUSTRIALIZED AREA OF NORTHERN GREECE AS VIEWED BY ESEM-EDX

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This study is focusing on the characterisation of secondary sulphate airborne particles collected from the Ptolemais-Kozani region (Western Macedonia), northern Greece. Most of the Greek lignite deposits are located in this large, intensively exploited area. This area is exploited by opencast mining and feeds nearby lignite-fired power stations. Four thermal power stations are located in this basin which account for 80% of the total lignite burning electricity production in Greece.
During a whole year (March 2003 to February 2004), several filters that capture airborne particles were collected from seven sampling sites spread throughout the area. Moreover, a silica wool filter was placed into the upper part of a lignite-fired power plant's stack in order to collect the so-called stack ash.
Filters of total suspended particles (TSP) and fine particulate matter (PM10 and PM2.5) and stack ash were analysed by Environmental Scanning Electron Microscope (ESEM), coupled with Energy Dispersive X-Ray analysis (EDX). Characteristic ESEM images and EDX spectra of fine sulphate airborne particulates are presented in this study. Their morphological characteristics vary from fibrous to hexagonal and platy twin crystals. Some of the identified calcium sulphates (mostly gypsum [$CaSO_4 \cdot 2(H_2O)$] and anhydrite [$CaSO_4$]) might originate from the lignite combustion, and particularly due to the reaction of sulphur-rich lignite with the calcium rich inorganic matter inside the thermal chambers of the power stations. Characteristic gaseous secondary electron (GSE) images of minute gypsum crystals covering the char or carbonate minerals of the stack fly ash are presented in this investigation. A Ca-rich hexagonal crystal covered with small elongated secondary gypsum crystals was revealed, suggesting the conversion of calcite to gypsum probably by the reaction of sulphur compounds and mineral aerosols and giving rise to the formation of sulphuric compounds coating the mineral surfaces. The identified agglomeration of elongated fine gypsum crystals might result from a reaction between Ca leached out form other calcium-rich particles and S derived from the high levels of atmospheric SO_2 in polluted areas. Fibrous, delicate gypsum crystals having a radial structure are also observed. It should be noted however that the formation of several such sulphates could be a sampling artifacts by the reaction of gaseous pollutants with the dust particles already collected in the filter.

SAHARAN DUST IN RED RAIN PRECIPITATED OVER ATHENS, GREECE, ON FEBRUARY 24TH 2006

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It is known that huge quantities of mineral dust are transported every year from the arid desert regions of northern Africa over the Mediterranean areas (3.9×10^6 tonnes yr^{-1}). Sahara desert is responsible for the global emission of 50% of the total mass of mineral aerosols to the atmosphere. It has also been recognized that aeolian transport of Saharan dust influences significantly the rain acidity and furthermore the climate to the Mediterranean, causing among others, intense 'red (or mud) rain' and even 'red snow' episodes. During these episodes geological material from Sahara is deposited to the aquatic, terrestrial and urban environment. However, it seems that the mineralogical and chemical composition of Saharan dust in 'red rains' differs in the western and the eastern part of Mediterranean. Mostly silicate materials (e.g. phyllosilicate minerals), together with quartz, are deposited in the Iberian peninsula, while more carbonate materials (i.e. calcite), also together with quartz, are historically deposited in southern Greece. Thus, we present herein a preliminary characterization of Saharan dust collected during a 'red rain' episode took place over Athens city on 24th of February 2006. The origin of the air masses were identified by calculating the 72-hours air mass back trajectories for different heights in the atmosphere, using the HYSPLIT 4 model of Air Resources Laboratory of NOAA. The solid particles were separated from the aqueous medium (exhibiting an alkaline pH) using membrane filters. The powder-XRD examination showed that the major minerals comprising the dust are quartz (SiO_2), calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$). The subsequent SEM-EDS investigation approved the previous observations whereas individual heavier mineral grains were also detected (titanite, rutiles, zircon, various Fe-oxyhydroxides) as well as minor phyllosilicates and Fe-sulphates. The Fe-oxyhydroxide phases, giving the red-brown color, were characterized as goethite (FeOOH) using Laser μ-Raman techniques. The bulk XRF analysis indicated that except major K, Ca, Fe, Sr and Ti, traces of Mn, Zn, Pb, Cr, Rb, Cu, Ni and Ga are present in the studied Saharan dust. On the other hand the γ-ray spectroscopic study showed very low natural radioactivity (^{40}K, ^{214}Bi and ^{226}Ra peaks), along with cosmogenic ^{7}Be produced naturally by cosmic-ray interactions with atmospheric constituents, and remarkably the absence of human-produced nuclides (such as ^{137}Cs) in contrast to previous literature data.

MINERALOGY OF INHALABLE PARTICULATE MATTER (PM_{10}) IN OLD PROCESSING AND SMELTING SITES: THE CASE OF LAVRION URBAN AREA

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The mineralogy of inhalable particulate matter in urban areas has recently received considerable attention, especially in areas of intense past mining, and metallurgy activities. Airborne mineral dust can have numerous repercussions on human health, the most notable and dangerous being the effects of inhaled particles on the human respiratory system. Several reviews detailing lung diseases that can result from exposure to mineral dusts discuss the changes in the respiratory system that occur with exposure to bioreactive dusts.

In Lavrion, after the re-opening of the mines in 1864, gravity separation and flotation processing of Pb-Ag-Zn ore, calamine calcination, and smelting of ancient slags and galena concentrates resulted in large stockpiles of wastes causing severe impact to the environment. Environmental studies of the early 1990's were focused in characterization of those pollution sources, while remediation measures were proposed and partly materialized [1]. However, most of the stockpiles and the heaps of slag still remain uncovered and exposed to weathering. Mineral grains are thus easily dispersed in the urban area as a result of a wind-induced process.

In this study the mineralogy of dust grains collected on air filters by using portable air pumps exposed for 8 hours as well as dust samples collected from outdoors flat surfaces within the Lavrion urban area was studied by means of X-ray diffractometry (XRD) and Scanning Electron Microscopy (SEM/EDS). The mineralogy of mineral waste, flotation tailings and slag stockpiled in the urban and the surrounding area was also investigated for comparison. The amount of Total Suspended Particulates (TSP) was below 200 μg/ m^3 for the particular day of sampling and the mineralogy of the few PM_{10} grains collected on the air filters is similar to that of dusts. The PM_{10} fraction of the dust is dominated by grains of carbonates (mainly calcite, Mg-calcite and dolomite), quartz, muscovite, chlorite and fluorite, originating from the dumps of the gravity separation mineral waste. Minor grains of a Pb-arsenate, a glassy Fe-Ca-Al-silicate slag phase high in Zn and Pb, and grains of a non-stoichiometric association of Fe-Pb-As and Pb-As elements (possibly a variety of mimetite) were identified. Lead minerals (cerussite, anglesite and plumbojarosite) are rarely found in most samples.

The results indicate that waste piles remaining uncovered and exposed to wind are a major source of fine metalliferous dust grains, highlighting the importance of inhalable dust as an exposure medium threatening the health of Lavrion population. However, in lack of data from areas with similar mining history and only few *in vivo* experimental research results on the topic, further research is needed to allow for reliable estimation of the health risks related with dust inhalation in Lavrion.

[1] Xenidis et al. 2003. *Advances in Environmental Research*, **7**, 479-494.

HEALTH RISK ASSESSMENT AND MOBILITY IN HAI PHONG, VIETNAM

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Haiphong is a seaport city, a major transport knot, a main gateway to the sea for the Northern provinces and a hub for economic development. The city has a multimodal transport system, which entails airborne, waterborne, road and rail transport. This provides many incentives to economic development. Recent major upgrades, such as the upgrading of the National Route No. 5, further improved the infrastructure for economic development.

However, the socio-economic progress brings also environmental concerns. One of the dominant environmental issues associated with transport is air pollution. In Hai Phong, transportation accounts for around 90% of total emissions of lead, 60% of total emissions of nitrogen oxides, and 50% of total emissions of carbon monoxides. Transportation also accounts for about 25% of the total amount of emissions of particulates of which diesel engines are the main source. As Hai Phong aims at increasing the capacity and productivity of the Hai Phong port, mobility and traffic activities in Hai Phong will definitely increase during the years to come. This will result in more environmental concerns related to transportation, such as the increase of air pollution and noise, and their associated health problems, injuries and morbidity. Therefore, there is a need for a systematic analysis of the environmental and social problems of mobility and transportation so that necessary measures can be established to protect the environment and human health.

In Vietnam, integrated planning tools are not well developed and utilised. Applications of GIS and environmental modelling for instance are not used for health assessment. The integration of health assessment in general environmental impact assessment is limited. Urban and transportation development projects make use of health impact assessment in limited way. The spatial and temporal scopes of such assessment are usually missing. This is where the research will contribute to the current knowledge and application in environmental impact assessment in general and health impact assessment in particular in Vietnam. The poster will provide information on the mobility in Hai Phong City and its predicted evolution and the initial results of the health risk assessment will be presented.

MICRONUTRIENT DEFICIENCY IN MATERNITY AND CHILD HEALTH: SCOPE FOR AGRICULTURAL AND EDUCATIONAL INTERVENTION IN SOIL-FOOD-HUMAN TRANSFER

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"No Society has ever seen a broad-based reduction in poverty without major and sustained investments in the rights of people to health, nutrition and basic education" UNICEF

Global food insecurity is associated with micronutrient deficiencies and it has been suggested that 4.5 billion people world wide are affected by deficiencies in iron, vitamin A and iodine. Zinc has also been identified to be of increasing concern. The most vulnerable are young children and women of childbearing age. This project, through multi and interdisciplinary research is seeking to establish the opportunity for concerted action to deliver step change improvements in the nutrition of developing countries. A research team crossing environmental, nutritional, medical and social science has been assembled to study the relationship between soil quality, food production and the nutritional health, behavioural and cultural attitudes of women and children in Malawi. We have identified two geographically separate regions close to Blantyre in S.Malawi and started to engage with a number of village communities through support from local NGOs. To date, our data collection has included field campaigns to collect spatial information relating mothers to their main food supply, provide observations on farming methods and dietary diversity. Our programme of soil and plant material collection is underway and first stage samples are currently being characterised for nutrient content and other parameters.

The next stage includes the development of health and lifestyle questionnaires, blood sampling protocols through intensive consultation with Malawi-based charitable and educational organisations, including modification for cultural and local sensitivities. In parallel, we are collecting social and anthropological observational information, compiled though diary reports.

Our overall assessment will require the development of protocols for spatial assessment and the statistical interpretation of chemical data from environmental, food and nutritional compartments, combining medical observations and the social context.

In the early stages of the project we have been able to assemble a research team which includes contributions from EU based soil scientists, environmental geochemists, midwives; medical, social and anthropological sciences as well as epidemiological and spatial analysis specialists. Engaging on the ground with such a diverse group has highlighted numerous logistical issues in this multifaceted research, typified by the equally diverse protocols and permissions which vary across disciplines. It is clear that local engagement and cultural/social aspects dominate health and nutritional interventions and it is essential we work from the ground up.

CONTAMINATED LAND: CONTRIBUTION TO THE BURDEN OF DISEASE

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Following the industrial revolution in the UK, it has been estimated that as many as 100,000 sites around England and Wales may be potentially contaminated with hazardous substances such as heavy metals, dioxins, phenol, benzene and other hydrocarbons. With the demise of many industries, a number of potentially contaminated sites were developed for housing and therefore could potentially have a significant public health impact due to the exposure to environmental pollutants. This poses the question 'what is the potential contribution to the burden of disease from exposure to contaminated land'.

Therefore, we carried out a literature search to identify areas of contaminated land due to anthropogenic activities, in order to assess the potential adverse health effects in surrounding communities as a result of exposure. Relevant areas were initially identified in the UK and then the rest of the world.

Initial literature searches indicated elevated concentrations of cadmium and chromium in soil in parts of the UK resulting from anthropogenic activities.
Worldwide, specific regions of Japan and Belgium have elevated concentrations of cadmium in soil. Similarly, regions of India and the US have elevated levels of arsenic; areas of Germany have high concentrations of trinitrotoluene; and areas of Japan, Australia and Italy are contaminated with dioxins.

In the UK, no causal relationship has been established between contaminated land and adverse health effects. However, worldwide, a possible casual link has been suggested to exist between land contaminated with arsenic and adverse health effects such as cancer; exposure to cadmium and renal dysfunction; and exposure to dioxins and cancer, cardiovascular disease and chloracne.

To conclude, in the UK, the available literature does not indicate that exposure to contaminated land significantly contributes to the burden of disease in the areas identified, although worldwide, adverse health effects due to residing on or near contaminated land have been suggested.

NATURAL AND ANTHROPOGENIC SOIL GEOCHEMISTRY CHARACTERISTICS OF BELFAST, GLASGOW, CARDIFF AND EAST LONDON IN THE UK

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The British Geological Survey's Geochemical Baseline Survey of the Environment (G-BASE) project is responsible for the systematic geochemical mapping of the land surface of Great Britain. Samples of soils, stream sediments and stream waters collected at an average density of 1 sample per 1.5 km^2 are determined for up to 46 elements/parameters. Concerns over land quality in population centres have raised interest in the concentrations and behaviour of chemical substances within the urban environment. This prompted the G-BASE project to expand the geochemical survey into urban areas. The sampling strategy of urban areas differs to that of the regional survey as only soil samples are collected, but at a much higher density of 4 samples per km^2. Top (5 - 20 cm) and deeper (35 – 50 cm) samples are collected at each site. 22 urban centres from different parts of the UK have been surveyed so far, giving an extensive dataset of over 16000 samples. This provides a unique picture of the status of UK urban soil chemistry.

In this study, various data analysis techniques have been used to identify the main features of urban soil geochemistry in Belfast, Glasgow, Cardiff and East London. One apparent outcome of the study so far is that there are similarities between all urban centres, such as elevated levels of contaminants such as Pb and Zn in comparison with the regional background. All four of the cities have a significant industrial past and the data indicate a legacy of soil contamination. For example, Glasgow housed a large chromium ore production plant which left the south-east of the city with extremely elevated concentrations of Cr. However, the concentrations of other contaminants, such as As and Cd are lower than might be expected given the extent and duration of the city's industrial heritage. This is also true of Belfast where the distribution of environmentally sensitive elements is most strongly influenced by the underlying parent material. Notably high concentrations of Cr, Ni and Cu are controlled by the presence of the Antrim Basalts. In contrast, in Cardiff, the long industrial history, is reflected in elevated concentrations of several contaminants, some of which (Zn and Sn) are amongst the highest observed so far in the 22 urban areas. The most recent urban data available are for the region of East London; the precursor to a major sampling effort that will take place in 2008 and 2009 to complete the survey of London.

GEOCHEMICAL MAPPING OF SOIL PB IN THE MINING VILLAGE OF STRATONI, GREECE: VARIATIONS BETWEEN DIFFERENT INTERPOLATION METHODS

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Geochemical mapping is an important tool for environmental assessment enabling recognition of spatial associations between contamination hot spots and potential sources of pollution. It is also very useful for communicating research results with stakeholders outside the scientific community through visualisation of relationships between geochemical parameters and various spatial features over an area. Various interpolation methods can be used for producing a continuous surface of a geochemical parameter from point sample data. However, the choice of the interpolation method can affect significantly the map output.

In this study, geochemical mapping of Pb in surface soil from a mining village in north Greece was performed by using two different interpolation methods: the deterministic method of Inverse Distance Weighted (IDW) and the geostatistical method of ordinary kriging. The subsequent comparison of these methods was based on criteria, including comparison of estimated minimum and maximum concentration values by each method and comparison of per cent area over certain concentration levels. The research methodology included chemical analyses of 36 surface soil samples (depth 0-5 cm) collected from house gardens on a 200 m x 200 m grid, covering a total area of 1.5 km^2. Sampling duplicates were also collected at 9 randomly selected sites 5 m away from the original sampling points for estimating sampling uncertainty and for setting the dimensions of the interpolated grid. The total content of Pb was determined by AAS after dissolution with a mixture of HNO_3- $HClO_4$ and HF acids.

Lead concentrations in soil samples ranged from 124 μg g^{-1} to 2042 μg g^{-1}. The total area characterised by Pb concentrations over 500 μg g^{-1} was estimated to be 80% of the total by both interpolation methods and a spatial pattern showing decreasing Pb concentration with increasing distance from the ore mill plant located on the NNE end of the village was observed. The spatial trend was more apparent when the geostatistical method of kriging was used, producing a smooth interpolated surface over the total study area whilst the deterministic method of IDW produced closed concentration curves around the sampling sites, highlighting the geochemical heterogeneity of surface soil in respect with Pb. Areas characterized by the highest elemental concentrations were also delineated, providing a criterion for prioritizing the remediation of contaminated land within the village.

LEAD DISTRIBUTION IN SOILS OF THE CULTIVATED AREA OF AGIA, THESSALY, CENTRAL GREECE

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One hundred seventy three (173) surface soil samples were collected in the cultivated area of Agia Larisa in order to examine the content and the spatial distribution of lead, to determine possible sources of origin and contamination of lead, and to evaluate possible effects on the environment. The collected samples were analysed by ICP – AES after digestion with a mixture of $HClO_4$ – HNO_3 – HCl – HF. Moreover, 10 (ten) representative samples were diluted by the addition of 0,5N HCl for the determination of the bioavailability of lead. The mean value of lead does not exceed the values of the phytotoxic levels (100-400ppm) and 71% of the lead contents are lower than the global soil mean concentration (10ppm). The treatment of the results showed that lead in the studied area is of an anthropogenic origin and is due to the application of fertilizers, pesticides and to the traffic. The performed tests of bioavailability showed percentages ranging between 44 and 100%.

A PILOT SCALE APPLICATION OF ATTAPULGITE CLAY FOR STABILIZATION OF HEAVY METALS IN CONTAMINATED SOILS

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Stabilization methods are routinely used in the remediation of contaminated land. Specifically, in the instance of contamination by heavy metals, the health hazard is controlled by chemically immobilizing the contaminants, thus reducing their bioaccessibility through oral, respiratory or dermal exposure. The choice of appropriate binders for application is an open field for research on the quest for the most effective mixing proportions at an affordable cost. This poster presents the methodology of a pilot scale application of a stabilization method for the remediation of heavy metals contaminated soil, using appropriate dosage of specific fraction size pure attapulgite clay. Initial results from laboratory experiments confirm that attapulgite clay is an extremely effective binder when mixed even with highly polluted soils. Based on preliminary data of field experiments the final results of the method depend on site specific physico-chemical and geotechnical soil characteristics, as well as contamination levels. Overall, the developed methodology is promising for remediation purposes at an affordable cost at the present market conditions.

SURVEY ON FLUORIDE, BROMIDE, CHLORIDE, NITRATE AND SULPHATE CONTENTS IN PUBLIC DRINKING WATER SUPPLIES IN SICILY (ITALY)

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Six hundred and sixty-seven water samples were collected from public drinking water supplies in Sicily and analysed for electric conductivity and for their chloride, bromide, fluoride, sulphate and nitrate contents. The samples were, as far as possible, collected evenly over the entire territory with an average sampling density of about one sample for every 7600 inhabitants.

The contents of chloride and bromide, ranging between 5.53 and 1302 mg/l and between < 0.025 and 4.76 mg/l respectively, correlated well with the electric conductivity, a parameter used as a proxy for water salinity. The highest values were found both along the NW and SE coasts, which we attributed to seawater contamination, and in the central part of Sicily, which we attributed to evaporitic rock dissolution. The nitrate concentrations were in the range 0.05 – 296 mg/l. Of the analysed samples about 4.4% exceeded the maximum admissible concentration (MAC) of 50 mg/l. The highest values were always measured in areas of intense agricultural exploitation. The sulphate concentrations varied between 6.03 and 516 mg/l, exceeding in about 1.2% of the cases the guideline level of 250 mg/l. The highest values were always related either to evaporitic rock dissolution or to seawater intrusion. The fluoride concentrations ranged from 0.023 to 3.28 mg/l, while the highest values (only 3 exceeding the MAC of 1.5 mg/l) generally attributed either to the leaching of crystalline (volcanic or metamorphic) or evaporitic rocks or to contamination from a hydrothermal component.

Apart from these limited cases of exceeding of MACs, the waters of public drinking water supplies in Sicily can be considered safe for human consumption for the analysed parameters. Some limited concern could arise from the intake of bromide-rich waters (about 3% exceeding 1 mg/l) because of the potential formation of dangerous disinfection by-products. Also nitrate concentrations, although sometimes exceeding MAC, display generally level well suited for human consumption, the population-weighted average being about 16 mg/l for the whole Sicily.

As regards geographic distribution, the best water quality was found in areas with the most humid climate and with huge aquifers in the north-eastern part of the island. On the contrary especially along the southern coasts of Sicily, arid conditions and the widespread presence of impermeable lithologies, sometimes forces the use of low quality water resources. But it is also worth to note that bad management often exacerbates water quality and quantity problems in these areas.

ARSENIC IN THERMAL WATERS OF GREECE

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The diffuse occurrence of As in natural waters, its relevant geochemical mobility in aqueous systems and its toxicity to human beings when consumed in enhanced doses, make this element one of the most problematic challenges of present water research. Arsenic in groundwater is often associated with geologic sources, but in some locations anthropogenic inputs can be extremely important. Volcanic degassing represents an important natural source of As to shallow aqueous systems. Arsenic is a minor but recurrent constituent of volcanic gases and geothermal fluids. It is also widely found in epithermal sulphide ore deposits, either as a major constituent (arsenopyrite, orpiment, realgar) or as a minor element in pyrite. As a result of the interaction with deep-rising fluids or leaching of ore deposits, groundwaters circulating in active volcanic-geothermal areas may contain high amounts of As.

Arsenic in groundwater represents one of the major global health issues exposing millions of people to the risk of cancer and other As-related diseases, especially in southern Asia. Furthermore, previous studies evidenced that widespread areas in northern Greece display As concentrations above the European Maximum Admissible Concentration (MAC) of 10 μg/l.

In this study As concentration were determined in 104 water samples collected in whole Greece. Forty-five of the samples are thermal waters (T > 30°C), 24 are hypothermal waters (T 20-30°C) and 35 are cold waters (T < 20°C). Arsenic concentrations span over 4 orders of magnitude ranging from < 0.2 to 5700 μg/l. They show a fair positive correlation with sampling temperature and cold waters exceed the MAC only in few cases. The contribution of geothermal activity to the As concentration of the studied groundwaters is further evidenced by the positive correlation between As and thermal-related elements like B, Li and F.

The samples are too few to highlight a clear geographic distribution and high As values (> 100 μg/l) are found both in continental Greece (Chalkidiki, Sidirocastro in the north; Thermopyles, Edipsos in the central part; Kaiapha in the Peloponnesus) and along the South Aegean volcanic arc (Methana, Nysiros).

GROUNDWATER QUALITY ISSUES IN THE FLORINA AREA (N. GREECE)

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The Florina basin developed in the Pelagonian Zone, the westernmost zone of the Internal Hellenides, in response to NE–SW extension in the Late Miocene and to a subsequent Pleistocene episode of NW–SE extension. Continuous sedimentation resulted in the accumulation of a 560 m thick succession of Late Miocene to Early Pleistocene lake sediments with intercalated lignites and alluvial deposits. The presence of intercalated volcanic ash beds of Pliocene age evidences volcanic activity related to the exstensional tectonics.

Groundwaters in the central part of the Florina plain display high levels of dissolved gases, which often separate in a free gas phase. Their composition is dominated by carbon dioxide, which accounts for 85-99% of these gases. Apart from small amounts of atmospheric gases, minor components are CH_4 (0.05-0.4%) and He (3-30 ppm). Carbon isotopic composition ranging from –1.6 to 0.3‰ (vs. VPDB) testifies for a deep (magmatic-hydrothermal) origin of CO_2 and also He isotopic composition (0.24-0.55 R/R_a) reveals a small (3.5-8.4%) but significant mantle contribution.

Furthermore the water composition of a deep well (Mesochori) shows important contribution from a hydrothermal component, displaying very high Li and B contents and a clear isotopic shift on a δD-$\delta^{18}O$ diagram. Geothermometric estimates of the deep reservoir are in the range 150-180 °C.

The uprise of mantle gases is related to the main tectonic structures, which probably allowed also magma intrusion episodes whose heat flow sustain the deep hydrothermal system.

Because of the huge input of CO_2, the shallow groundwaters of the studied area become acidic and consequently strongly aggressive with respect to the host rocks. At the sampling point many waters display pH values down to 5.5, being generally under the lower limit for drinking waters. Intense rock leaching results in metal release to the solution and enhanced metal fluxes in the aqueous system. As such, magmatic-hydrothermal CO_2 input produces a "natural pollution" of the aquifer, where maximum admissible concentrations (MAC) fixed by European Union for drinking waters are exceeded at least for Ni, Mn and Fe in most of the analysed samples. Measured values reach respectively up to 30, 1700 and 55000 μg/l (MACs 20, 50 and 200 μg/l). This natural contamination combines with the pollution due to agricultural practices in the Florina plain, which is responsible for elevated nitrate contents (up to 90 mg/l) often exceeding maximum admissible concentration (50 mg/l).

The interaction of natural and anthropogenic contamination of the shallow groundwater resources in the Florina area leads to serious water quality issues.

HYDROGEOCHEMICAL RESEARCH OF THE NEOGENE AQUIFERS AT THE KARLOVASI BASIN OF SAMOS ISLAND, GREECE

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The aim of the present study was the combinational use of water quality contamination index, geostatistical methods (correlation analysis and R - mode factor analysis) and geological data for the assessment of groundwater contamination in the Karlovasi basin of Samos island. For this reason a number of eighteen (18) water samples were collected from boreholes and springs and they were analysed for major cations, anions and trace elements. The combinational results showed that the quality of groundwater is due to evaporite and carbonate minerals and probably sulphide minerals (Zn - Mn sulphide mineralization and Mo - As silicified mineraliztion). The arsenic (As) values vary between 1 and 150 ppb with almost 45% of them above the proposed upper limit of 98/83/EU Directive.

HEXAVALENT CHROMIUM AND OTHER TOXIC METALS IN GROUNDWATERS OF THE ASOPOS VALLEY (ATTICA), GREECE

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Trivalent chromium is the dominant form in the environment (soil, in many fresh vegetables, fruits, meat, grains) whilst hexavalent chromium is soluble in water and it can migrate in the direction of the groundwater, under highly oxidizing conditions and pH values over 7. Since September 2007, the University of Athens has started sampling groundwater and surface water and from several sites of the Asopos valley, where industrial activities are well known during the last 30 years, in order to investigate the Cr6+level in drinking water. Concentrations over the maximum level of total Cr in drinking water (50 ppb, according to the EC Regulation) were found in the urban water supply of Oropos (up to 80 ppb Cr6+), Oinofyta (up to 53 ppb) and Nea Ekali (62 ppb Cr6+). High concentrations of Cr6+, ranging from 5 to 33 Cr6+, were also found in the water of the town of Thiva. With the exception of the As, the Pb, Ni, Cu, Cd, Hg, Sb contents in 28 groundwater samples, that are representative of all water types, analyzed for Cr- Cr6+, were lower than permeable limits. High As content (up to 34 ppb As) were detected in central water system of Dilesi. The contamination of groundwater by Cr6+ that was found in the majority of water drillings in the Asopos valley is related to the widespread industrial activity and the usage of hexavalent chromium in various processes. In order to reduce the concentration of total chromium below the EC maximum contaminant level (50 ppb) and the proposed level for Cr6+ by other countries, remediation strategies should focus on the reduction of Cr6+ to the insoluble trivalent forms, that are relatively stable and non-toxic. Recently, a removal process of hexavalent chromium, using scrap iron filings, has been proposed: $Cr6+ + Fe0 \rightarrow Cr3+ + Fe3+$ Trivalent chromium and total iron can be removed from the aqueous solution by precipitation with alkaline solutions. This is a low-cost method for the reduction of Cr6+. Hexavalent chromium in groundwater of the Asopos valley is related to the anthropogenic activities in that region (from the discharges of Cr-bearing wastes), rather than ultramafic ophiolitic rocks, as is exemplified by a strong positive correlation between Cr6+ and Mg ($r = 0.88$) only in the latter.

According to the literature and our experimental work, the Cr6+ in the above measured concentrations, can be removed from drinking water by using an activated carbon filter. Our preliminary results may indicate that all Water Protection Agencies, in addition to those elements listed currently, must require information about the hexavelent chromium as well, in particular in the bottled water. Also, monitoring may help local municipalities in the Asopos valley to determine where certain contaminants occur and whether the contaminants need to be regulated.

FROM LABORATORY TO FIELD: DEVELOPING FIELD SCALE ELECTROKINETIC REMEDIATION TECHNIQUES FOR NUCLEAR SITE SOIL WASTES

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One of the major environmental legacies of military and civil nuclear activities has been the generation of areas of land contaminated with anthropogenic radionuclides, due to authorised/licensed or accidental discharge. Considerable research and financial effort has consequently been expended on a range of *ex-situ* and *in-situ* methods which can be used to remediate or stabilise radioactively contaminated soils and sediments, including phytoremediation, soil washing, stabilization and bioremediation. While these technologies have been applied in a range of environments, their application in clay- and silt-rich soils and sediments is problematic, due largely to the low hydraulic conductivities of these materials. One emerging technology that has, however, received much attention as a practical *in-situ* remediation technology for clay-rich soils is electrokinetic remediation. This paper details the on-going development, via a DTI and AWE-funded Knowledge Transfer Partnership (KTP) between the University of Brighton and AWE plc, of novel on-site electrokinetic remediation methods for the decontamination of nuclear site soil and sediment wastes.

The Atomic Weapons Establishment (AWE) at Aldermaston (Berkshire, UK) has manufactured and maintained the warheads for the U.K.'s nuclear deterrent for more than 50 years. Nuclear weapon manufacture and maintenance, and related research and development activities, have produced small amounts of radioactive (principally plutonium, tritium (^{3}H) and uranium-containing wastes), heavy metal and organic chemical wastes, which were processed and disposed of, in accordance with contemporary handling and disposal practices, to the local environment. Historical disposal practices that were considered acceptable at the time have subsequently generated a number of contaminated land legacy issues, involving hydrocarbon, trichloromethane, trichloroethene, mercury, ^{3}H and Pu contamination. In terms of radionuclides, whilst the site is radiologically safe, soil/sediments in a few locations contain above-background specific activities of Pu arising from these historical operations. Previous work on Pu contamination at the site has indicated that the Pu is strongly sorbed to site soils/sediments, with little redissolution. An amount of the Pu-labelled soil has been removed (via soil excavation), and is held in containment units on site, prior to remediation / decommissioning. It is this material that forms the focus of the current research programme.

Preliminary electrokinetic trials on AWE site soils and sediments have demonstrated significant mobilisation and removal of a range of trace elements and contaminants; notably Mn, Zn, Sr, U, Ca. Pore water samples analysed for plutonium indicated mobilisation of Pu into soil pore waters by the electrokinetic treatment process, with Pu present at activities of 21 -35 Bq/L. These measured Pu activities are 50,000 times greater than those found in soil pore waters under natural conditions, indicating significant removal of Pu from the solid phase.

The remobilisation of a range of elements, using real site materials, indicates the potential usefulness of these electrokinetic techniques in nuclear site remediation. Current work involves further laboratory trials to investigate effects of voltage, current, ionic solution, soil preconditioning and electrode configuration, followed by an intermediate scale laboratory trial to simulate field scale conditions. Experimental work will culminate with a field scale trial to treat approximately 4 tonnes of soil on at AWE. Following experimental work aspects for future development will be identified and a long term soil remediation strategy devised.

ENVIRONMENTAL IMPACT OF PT, PD AND RH FROM CATALYTIC CONVERTERS ALONG ROADSIDES AND POSSIBILITIES FOR THEIR RECYCLING: EVIDENCE FROM GREECE

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The increased use of Pt, Pd, and/or Rh in automobile catalyst converters, has led to their release into the environment and biological accumulation on roadsides, since 1993 in European countries. Traffic emissions and their impact on urban air quality, health, and atmospheric processes have been the subject of increasing interest in recent years. Representative roadside dust samples (n = 14), topsoil samples (n = 9), grass samples (n = 22) and leaves from trees (n = 7) were collected from the Katehaki, Messoghion and Iera odos high way roads, and the Pindos and Navarinou residential roads. They were analysed for several trace elements, including precious metals for this pilot study. Platinum ranges between 210 and 960 ppb (average 430 ppb) in dust samples and from 44 to 820 ppb (average 560 ppb) in soils. Palladium ranges between 180 and 1300 ppb (average 250 ppb) in dust samples and from 36 to 1100 ppb (average 300 ppb) in soils. Dust collected from parts of the roadsides near water sewerages reached as high as 2070 ppb Pt and 1980 ppb Pd contents. Palladium was the most abundant PGE in the grasses ranging from 0.6 to 23 ppb (average 7 ppb), while Pt ranges between 2 and 7 ppb (average 4 ppb), suggesting that they are more bioavailable to plants than Rh (< 0.1 ppb). An increasing trend between Pt and Pd contents in plants and the associated soils, is consistent with their solubility in soils and confirm their bioavailability.
Apart from the negative environmental impact of the catalytic converters in automobiles along roadsides they may become an economic resource for the PGEs. Platinum and Pd may be recovered from scrapped automobile catalysts and from road dust. The significant Pt and Pd values (>4 ppm Pt+Pd) in road dust, near water sewerages of the Katehaki road, coupled with the global increasing use of catalytic gasoline and diesel, suggest a possible concentration of traffic-related emissions within reservoirs connected to the local water sewerage systems, and a new resource for the Pt and Pd recycling.

CHEMICAL SPECIATION AND MOBILITY OF HEAVY METALS IN TAILINGS FROM THE SAMSANJEIL CU MINE, KOREA, AND ENVIRONMENTAL EFFECTS ON NEIGHBOURING RESIDENTS

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The abandoned Samsanjeil mine is located in Gosung area, Korea and in 2004, similar symptoms to itai-itai disease from neighbouring residents were reported. Several studies have been carried out to investigate the possible relationship between reported case and the heavy metal contamination from that mine. However, no clear conclusions have been made on that matter. Concerning on this, we studied chemical speciation and mobility of heavy metals in tailings from the Samsanjeil mine and also investigated those changes at different depths. Seventeen samples were collected at two sampling sites (NN and SN) with interval of about 10 cm from the surface. XRD, SEM, and 5-step sequential extraction method were mainly used for our study. Concentrations of 8 (Cu, As, Zn, Pb, Co, Cr, Ni, Cd) heavy metals were analyzed by ICP-MASS. The pH values of two sampling sites showed very different tendencies with depth; pH values become lower rapidly in NN site with increasing depth (from 7.2 to 2.8), whereas no significant change was observed in SN site (8.1-8.8). By XRD, major minerals such as quartz, microcline, muscovite, and chlorite were identified with small amount of gypsum, calcite, and jarosite. Jarosite occurred only at the lower part of NN site at which calcite was not identified. This indicates that calcite plays important role buffering pH in our study sites. The concentrations of heavy metals in the tailings were in the order of Cu>As>Zn>>PB>Co>Cr>Ni>Cd. The concentrations of heavy metals at different depths did not change significantly. Sequential extraction study shows that large fractions of heavy metals except Cd were in the phase bounded to Fe and Mn oxides and in residual phase. The chemical speciation of heavy metals showed different trends with depth. For example, with increasing depth, Cu, Zn, and Co showed increasing fraction for exchangeable metals. This increasing fraction was closely related with low pH in NN site. For the samples from SN site, which showed high pH ranges, however, the fraction of exchangeable metal was very small. This result indicates that pH is very important factor controlling the mobility and possible toxicity of heavy metals in study sites. The concentration of Cd, which was most concerned metal here, was very low and the possibility of Cd from this mine to be the cause of itai-itai symptoms was also very low. However, compared with other metals, large fractions of Cd, Cu, and Zn existed as exchangeable metals or metals bound to carbonate, and as a result the mobility of these metals were relatively high. Therefore, the toxicities of those metals are also relatively high and even though the relationships between Cd and itai-itai symptoms seemed to be low, continuous attention has to be taken to monitor the possible impact on the neighbouring residents.

MINERALOGICAL CHANGES IN THE WEATHERING OF MINE TAILINGS AND THEIR ROLES IN CONTROLLING TOXICITY

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When mine tailings are migrated and especially if they are deposited on the vulnerable sites such as riverside where toxic metal can be easily leached out, sometime the environmental impact is very severe. In the upstream of Nakdong river in Korea, large areas of riverside were covered by weathered mine tailings which were deposited by flood and the impact of those on the river water and eventually the health of neighboring residents has been concerned. The deposits were composed of brown, red, yellow, and black layers. We studied the mineralogical changes in weathered mine tailings in order to understand the behaviors of heavy metals and their relationship with mineralogical changes during weathering process, and their impacts on the neighboring residents. We used X-ray diffraction (XRD), scanning electron microscope (SEM), energy dispersive spectroscopy (EDS) and those results were compared with chemical analysis. The primary minerals identified XRD were quartz, feldspar, mica, and Mn-pyroxene in the deposits. Gypsum, bassanite, goethite, kaolinite and jarosite were secondary minerals indentified largely in the red or brown layers. By EDS, Mn-oxide phase, which is the weathering product of Mn-pyroxene, was identified in the black layers. Iron sulfate phase (probably jarosite) was identified which was derived by weathering of pyrite, and gypsum was also detected, which was formed from calcite and pyrite. Schwertmannite was also detected by EDS which is the intermediate phase before being transformed to goethite. However, the most abundant secondary minerals were iron oxide (goethite) and Mn-oxide. By chemical analysis, Zn and Pb were the main heavy metals in the deposits and they were principally bound to or absorbed on Fe-Mn oxide phases. Fe-Mn oxides coated on other minerals such as quartz and feldspar also contain high concentrations of those metals by EDS, indicating that heavy metals leached from mine tailings can also be adsorbed on or coprecipitated with Fe and Mn oxides which are formed by weathering. It also indicates these secondary phases reduce the possibility of leaching of those metals from mine tailings even on the riverside if the original mine tailings contain large amount of minerals containing Fe and Mn minerals which can be easily weathered. Our study shows that the mineralogical contents and the weathering process are very important factors controlling environmental impact of mine tailings.

SITE INVESTIGATIONS IN VIEW OF THE ESTABLISHMENT OF A MONITORING NETWORK FOR PUBLIC HEALTH PURPOSES: THE FORMER CU-ZN-PB (CD) MINE AT KIRKI (GREECE)

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The present work summarises the strategy for site characterisation in view of the establishment of a monitoring network for pollution of rivers, groundwater and soil resources by heavy metals released by an abandoned mine. The former mining area of Kirki (Agios Phillipos) is situated at 22km NNW of Alexandroupolis, Thrace (NE Greece). A total of 214.000 tonnes of base metals ores, mainly lead and zinc, were extracted from 1973 to 1982 and then from 1989 to 1995, by underground mining and subsequently by open cast mining. Ores were beneficiated by flotation in a plant located 5 km south of the mine. The site was abandoned since then, without taking any safety or environmental precautionary measures.

The Kirki site provides a typical example of an abandoned mine site with significant potential environmental hazards, requiring monitoring and mitigation. It displays: uncontrolled exposure of open pit, mine cavities and galleries, acid mine drainage (AMD) from runoff, and acid drainage (ARD) potential from exposed pit and waste piles, potentially toxic metal migration, enhanced by AMD/ARD, and dissemination to surface and groundwater, uncontrolled hazardous waste storage (concentrates, process reagents in barrels including sodium cyanide, toluene diisocyanate and other hazardous chemical substances), and uncontrolled tailings storage, with high risk of dam failure. The main vector for mine pollution transport is the Kirkalon River, which receives all of mine water and suspended load. All water inputs are channelized into a narrow valley. Exchange between water and solid phases during transport is a significant process. Neutralisation of contaminated water occurs progressively, often within 100m and always within less than 1km, along with strong oxygenation of water at the outlet. This results in a strong reduction of metal solubility and precipitation of metallic salts which are carried as suspended matter or settled as sediments. Downstream of the ore processing plant site, pollution is carried in solute or solid form by the Eirini river water to the Alexandroupolis area. Downstream transport of solids occurs at a large scale during floods and ends up into discharge into the sea.

In the Alexandroupolis area, where most of the human settlements and agricultural activities are located, metal pollution may cause significant health risks through river water and groundwater use, and through soil contamination.

This work is funded by the European Union, 3rd Community Support Framework (2000 - 2006) - Operational Framework Programme “Competitiveness”.

ECOTOXICITY OF SLUDGE FROM WASTE WATER TREATMENT PLANT

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Utilization of sludge from communal waste water treatment plans for improvement of agricultural soils and for land reclamation represents currently important problem in the Czech Republic. In most cases, sludge from waste water treatment plants does not meet the maximum limit values for PAHs (12) in dry matter (6 mg/kg). The value of geochemical background for PAHs in dry matter of sludge is in the Czech Republic around 22 mg/kg. The average value for the Central Waste Water Treatment Plant Ostrava (350 000 equivalent inhabitants) is 50 mg/kg of dry matter. Immobilization or inhibition lower than 30 % is required for land reclamation purposes (*Poecillia reticulate* or *Brachydario rerio* – 96 hours, *Daphnia magna* Straus – 48 hours, *Raphidocelis subcapitata* - *Selenastrum capricornutum* or *Scenedesmus subspicatus* – 72 hours, seeds of *Sinapsis alba* – 72 hours, tentative tests are performed on luminescent bacteria *Vibrio fischeri)*. Inhibition of 100 % was determined for sludge processed by liming. For sludge in original state without liming, inhibition was slightly lower – 89 %. Inhibition in the water leachate from sludge can be caused by high concentration of dissolved matter, presence of ammonium in alkaline environment, organic pollutants, concentrations of heavy metals and their synergic effects.
For materials with high content of organic component (sediments) contaminated by PAHs, immobilization is achieved by addition of powdered active coal (5-10 % according to the content of PAHs). The concentration of PAHs in water leachate decreased, after addition of active carbon (10%), to the value approximately 5µg/l, which is below LC_{50} for aquatic organisms. Phtalates (0.16 mg/l) were the only organic component identified in leachate. The water leachate was separated into hydrophobic and hydrophilic fraction and inhibition of *Vibrio ficheri* (56%) was proved for both fractions. Concentration of Cu in water leachate of non-limed sludge are approximately 10 times higher than value LC_{50} which is required for *Daphnia magna* (1-10 µg/l). In limed sludge, concentrations are approximately 10 times higher due to forming of soluble humates in alkaline environment. Although Cu concentrations in dry matter of sludge meet the legislative requirements for its utilization in land reclamation, its concentrations in water leachate can be higher than it is allowed.
The utilization of active carbon and analysis of risk elements in leachate confirmed that presence of active carbon help to decrease the concentrations of risk elements in water leachate but after liming aimed at elimination of pathogens, the concentrations of risk elements (Cu, Cd, Zn, Cr) increase approximately by 1/3. From technological tests it results that process of sludge hygienization represents important increase of the sludge ecotoxicity. Concentrations of organic pollutants can be minimized in water leachate, however the value of inhibition required by legislation is not achieved. It is highly probable that especially Cu is mostly contributing to the value of ecotoxicity.

NATURAL RADIOACTIVITY OF ROCK SAMPLES FROM THE GREATER ATTICA REGION, GREECE

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According to an early survey, performed by the then Department of Uranium Exploration of N.R.C. "Demokritos" in the years between 1979 and 1986, the most significant radiometric anomalies in central Greece (Sterea Hellas) are related to lignites, bauxites and limestones. In the case of lignites and limestones the elevated natural radioactivity was attributed to the relatively high U concentrations (up to ca. 95 ppm in clay-bearing lignite from Atalanti, Phthiotis) while in the case of bauxites the sources of radiation were not clearly determined. In the greater Attica region, including the urban area of Athens and the surrounding metropolitan area (Attica basin) with a population of about 4 million, the only remarkable radioactive geological material was reported to be the Triassic "phosphorus-bearing bituminous limestone" of Mt. Kithaeron (up to ca. 47 ppm U). This formation had also been described in a previous unpublished report as "U-V-bearing phosphorite". Nevertheless, a recent investigation [1] revealed that radioactive rock samples, which can currently be found at Mt. Kithaeron area, concern in fact uraniferous carbonate rocks (ca. 14 to ca. 55 ppm U) with no evidence of increased phosphorus concentrations. In the present work we present natural radioactivity measurements (by laboratory γ-ray spectrometry/HPGe detector) the above rocks, which can be described as stratiform bituminous calcitic limestones of relatively lower radioactivity (164 Bq/Kg for ^{238}U, total dose rate: 76 nGy/h) and tectonized dolomitic limestones of higher radioactivity (724 Bq/Kg for ^{238}U, total dose rate: 344 nGy/h). Further investigations in the greater Attica region indicated insignificant radioactivity in limestones and marbles of the Attica basin (Mt. Lycabettus and Tourkovounia, Mt. Hymettus, Mt. Penteli, Mt. Aegaleo, Liosia area) as well as in the low-grade metasedimentary rocks known as the "Athens schists". However, the volcanic rocks (dacites) of Ag. Theodori area (Sousaki volcano) and the crystalline basement rocks (orthogneisses) of Mt. Penteli exhibit significant natural radioactivity (105 and 147 nGy/h respectively) mainly due to the contribution of ^{232}Th series (54 and 90 Bq/Kg respectively) and ^{40}K (1080 and 1737 Bq/Kg respectively).

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ESTIMATION OF BASELINE CONCENTRATIONS FOR THE EVALUATION OF SOIL CONTAMINATION AT LARYMNA, HELLAS

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Iron-nickel ore, formed through lateritic weathering of Mesozoic ophiolitic ultramafic rocks, is being mined from the Larymna mining district (Central Hellas) for more than a century. In addition, ongoing metallurgical activities for a period of over forty years produced a considerable amount of solid, liquid and gaseous wastes, the most significant of which are slags, derived from the reduction-smelting and the processing-refinement stages of the pyrometallurgical ore processing.

The aim of this study, financed by the Third Community Support Programme, is the assessment of potential environmental impact of the mining and metallurgical operations on soil. In order to evaluate the degree and extent of potential contamination in the study area, soil was sampled at a density of 2-3 samples/km^2 (n=229). Soil samples have been analysed for Fe, Ni, Cr, Co, Mn, Cu, Zn, Cd, Pb, V, As, and Sb and the necessary physicochemical parameters (e.g., pH, particle size analysis) determined. The chemical composition of ore and slag has been also determined on randomly selected samples. In addition, the mineralogy of representative soil samples has been studied.

In Larymna, as it has been originally considered, the elements playing the "protagonistic" part in the chemical composition of ore (Fe, Ni, Cr, and Co) proved to greatly exceed the respective global and/or national averages for natural non-mineralised soils. Interpretation of soil geochemical data was based on geological, mineralogical, geochemical and mineralisation factors. Geochemical patterns were used to determine the local natural baseline variation, which is the "fingerprint" of natural geogenic processes on soil. These were subsequently used for the estimation of site specific limits for toxic elements.

Generally, national statutory guide levels, set for toxic elements, depend mainly on their disease-generating character. Thus, in cases where contamination is due, not only to human activities, but also to mineral occurrences and/or deposits, the local baseline concentrations for potential contaminants, in relation to national statutory trigger levels, is crucial for the evaluation of contamination intensity and size of contaminated area.

The actual contaminated area, delineated through the recognition of contamination-patterns in the Larymna district, is in fact a small-sized zone, consisting of a series of independent high "point-values" in the direct vicinity of major contamination sources.

HEAVY METAL POLLUTION IN A MEDITERRANEAN LAGOON

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Mar Menor lagoon is located at the southeast coast of Spain, in Murcia region. It is one of the largest hypersaline coastal lagoons in the Mediterranean Sea. The lagoon is included in the Ramsar List of Wetlands of International Importance. It is also a Special Protected Area under the EU Wild Birds Directive (SPA) and Site of Community Importance (SCI) included in the Natura 2000 Network (EU Habitats Directive) (1). It is threatened by environmental degradation due to the urban growth around it, the intensive agriculture in its watershed and the remains of significant mining activities in the nearby Cartagena-La Unión area (2).

Heavy metals enter the food chain and bioaccumulate in marine flora and fauna. This way they may cause health problems to aquatic organisms and probably humans, as has happened in the past. The message of the Global Day of Wetlands this year was 'Healthy wetlands-Healthy People' (3). The present study aims at estimating the levels of zinc, copper and lead specific heavy metals in the water, the sediments and the marine flora and fauna of Mar Menor lagoon.

Total zinc values in the water column ranged between 9.36 μg/L and 28.7 μg/L, while copper concentrations varied between 0.548 μg/L and 2.18 μg/L. A high percentage of the values were increased in comparison to unpolluted lagoons.

Total heavy metal levels in the fine sediment fraction were 90-3372 μg/g for zinc, 3-61 μg/g for copper and 93-2977 μg/g for lead. Almost the whole quantity of zinc and lead and more than half of copper was found in non-lattice held mobile forms indicating elevated bioavailability. Moreover, in three sediment cores there is a clear downwards reduction of the heavy metal load. Heavy metal concentrations increase also from the northwestern to the southeastern part of the lagoon.

Zinc, copper and lead were measured in the whole plant, the rhizome and the thallus of four marine flora species. In general, the plant thallae contained higher heavy metal loads than the rhizomes. The ranges, for the full plant, were 52-234 ppm for zinc, 2-28 ppm for copper and 62-119 ppm for lead.

From the three benthic fauna species studied, it was observed that heavy metals accumulate mostly in the animal flesh. The ranges of heavy metal values for the full animal were 16-1862 ppm for zinc, 3-46 ppm for copper and 31-60 for lead. These values show up the effect of heavy metal pollution in the lagoon ecosystem.

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A GEOCHEMICAL APPRAISAL OF OIL SEEPS AND ASMARI RESERVOIR OILS FROM THE MASJID-E-SOLEIMAN OILFIELD SOUTH WEST IRAN

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In this study the genetic origin of oil seepages occurring in Masjid-e-Soleiman oilfield is identified. Masjid-e-Soleiman the first oilfield in Middle East explored in 1908. After completing well No. 306, the sour hydrocarbons were recognized from Khami Group Formation. At present the oil seeps with H_2S gas has polluted some areas such as Seeberenj, Dare-Khersan, and Tenbi in the city. The mount of Hydrogen Sulfide is as high as 200 times the standard, forcing local people to evacuate their houses.
Asmari oil samples from Masjid-e-Soleiman oilfield and oil seeps from Seeberenj and Dare-Khersan were analyzed by Gas Chromatography-Mass Spectrometry. The best similarity between Asmari oil and oil seeps is achieved by high C_{27} over C_{29} sterane ratios (1.01-1.2), the low ratio of C_{29} to C_{30} hopanes (0.63-0.71), as well as the star diagram of tricyclic terpane. For the Asmari oil and oil seepages, high ratios of steranes to hopanes are very typical (0.60 for oil and 0.48-0.63 for oil seeps) and low ratio of C_{34} over C_{35} homohopanes (0.84-1.15) that are characteristics for algae organic matter deposited within anoxic environment. This is also supported by low amounts of C_{30} moretane relative to C_{30} hopane ($C_{30}\beta\alpha/C_{30}\alpha\beta$: 0.09–0.11), indicative of strong marine input to the source rock. Both oil and oil seeps present low C_{26} over C_{25} (0.66-0.95) and C_{24}/C_{23} (0.45-0.68) tricyclic terpane ratios (less than 1), low abundance of C_{29}/C_{30} hopane (0.63-0.71) and the occurrence of diasteranes, suggest carbonate-marl source facies for oil and oil seeps.
The ratios of 20S/(20S+20R) for $\alpha\alpha\alpha$ C_{29} steranes (0.48-0.51) and $\beta\beta$/ ($\alpha\alpha+\beta\beta$) for 5α-C_{29} steranes(0.5-0.54) have been evaluated together with the ratios of 22S/ (22S+22R) for C_{32} homohopanes (0.52-0.54). Based on these ratios, all samples are well within the oil window. Age-specific biological marker including, Extended Tricyclic Ratio (0.5-0.52), C_{28}/C_{29} (0.79-0.89) sterane ratios, and Oleanane Index (<0.2) show that oil seeps have similar source age as Upper Jurassic-Cretaceous.
The geochemical parameters showed that the oils and oil seeps were formed in similar depositional environment and have identical thermal maturity level (early oil window). In triangle diagram, the C_{27}-C_{28}-C_{29} sterane distribution for Asmari oil and oil seeps are located in the same vicinity indicating the source of initial organic matter being one and the same. Finally it can be concluded that the source of pollution in the area is Asmari reservoir oil and due to its pressure drop, the previously condensed H_2S gas is now free to escape through cap rock fractures, forcing people to evacuate their houses.

TOXICITY AND INTERACTIVE EFFECTS OF PENTACHLOROPHENOL, ORGANOTINS, NICKEL AND CYANIDE ON THE SEAWATER BRINE SHRIMP *ARTEMIA FRANCISCANA*

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The increase of environmental contamination by various kinds of compounds, originating from many sources, has established today the use of model systems, which are organisms-indicators of pollution. These organisms serve as models, to assess the impact of toxicants on higher animals and human beings.
Among marine invertebrates, *Artemia franciscana* is one of the most commonly used species, for various reasons. The aim of this study was to evaluate the interactive toxic effects of five toxicants on *Artemia,* namely trimethyltin (IV), dibutyltin(IV), pentachlorophenol, cyanide and nickel(II).
For the toxicity tests, after the incubation of *Artemia* nauplii along with toxicants was completed, the number of dead nauplii for each metal concentration was counted and the % mortality was determined. Toxic action was expressed in terms of LC_{50} values, i.e. the concentration of the toxicant killing the half of the total number of the initial organisms. Trimethyltin proved to be the most toxic compound towards *Artemia* nauplii, whereas nickel was the least toxic one. Cyanides were moderately toxic, whereas the toxicity of pentachlorophenol was comparable to that of dibutyltin. The interactive effect between each of organotins and pentachlorophenol on survival of *Artemia* was **synergistic,** whereas between organotins **antagonistic** action was observed. Finally, the combined effect of three toxicants (trimethyltin, dibutyltin and pentachlorophenol) acting simultaneously, was **synergistic.**
This result is very important, because is an indication, that pentachlorophenol, an organic substance, stimulates the synergism between itself and each organotin compound in such extent, resulting in overcoming the antagonism between the two organotins. Therefore, further experiments are necessary, in order to elaborate a more integrated and precise model about the impact of toxicants on *Artemia* and to make extrapolations for the behaviour of *Artemia* in the interactions with its ecosystem, in general.

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ARSENIC CONCENTRATION VALUES IN SEA SEDIMENTS OF THE FILIPPOS B PORT, KAVALA, NORTHERN GREECE

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High contents of potentially toxic trace elements can be an important hazard for the surface sea sediments. The trace element inputs on this environment can be related to natural, as the weathering of parent rocks, and anthropogenic processes, as different industrial activities. Nine sampling sites in Filippos B port, Kavala, Northern Greece and adjacent areas to the east and west were selected and analysed for their content in arsenic. The main industrial activities in the area are the Phosphoric Fertilizer Industry (P.F.I.) and the Kavala Oil land facilities. In past and recent years arsenic has raised a lot of attention since it is considered highly toxic and a class A carcinogen. Arsenic was extracted by using analytical reagent grade nitric acid and its concentrations were determined in all samples by Inductively Coupled Plasma –Mass Spectrometry (ICP–MS). The concentrations ranged from 2.7 to 44.8 mg kg^{-1} and its average was 15.3 mg kg^{-1}. Two samples that had concentrations higher than 20 mg kg^{-1} were in front of the P.F.I. facilities and the phosphogypsum dumps. However, a possible contribution of the element from the PBG sulphide ores that are present in the area may not be excluded. A comparison between the concentrations found in the present study and internationally accepted guidelines (i.e., The New Dutch list) showed that the aforementioned samples exceeded the suggested as optimum level (29 mg kg^{-1}), while one of them has a concentration that almost reaches the level (55 mg kg^{-1}) where remediation actions should be taken.

STUDY OF HEAVY METALS SPECIATION IN SEDIMENTS OF MALIAKOS GULF

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Marine sediments usually act as an important sink of metals entering coastal areas from human activities. However they can act as a secondary non-point source by releasing the labile fractions of metals to the overlying water column, with harmful effects on the ecological health of aquatic ecosystems. The human population that lives in coastal areas has been continuously increasing in the last few decades and the deterioration of ecosystems may also cause significant problems in human health. In order to assess the potential environmental impacts of contaminated sediments on biota, we need detailed studies about the chemical forms of heavy metals because they affect their bioavailability and toxicity.
The objective of this study was to determine the concentrations, distribution and fractionation of some metals, of environmental and ecological priority, in surface sediments of Maliakos Gulf, which is a semi-closed gulf , includes the estuary of Sperchios River and is included in the Natura 2000 network. It is polluted mainly by agricultural activities but the increasing urbanisation on its coast and some industrial activities contribute as well.
The modified BCR three-step sequential extraction procedure was applied in order to fractionate heavy metals in the sediments. For the determination of the residual metal concentration of the sediments, complete sample dissolution was achieved by using $HF/HClO_4/HNO_3$ acid mixture in closed PTFE vessels. The concentrations of Cd, Pb, Cr, Zn, Cu, Mn, and Fe were analysed by Flame and Graphite Furnace Atomic absorption Spectrometry. A reference marine sediment was also analysed .
The highly toxic metals Cd and Pb were mainly found in the first ‘‘mobile’’ fractions at percentages of up to 80%, indicating that their highest proportion is bioavailable, although total concentrations were not considered to be high in comparison to heavily polluted areas. They are metals of high priority in the environmental monitoring of Mediterranean coastal areas. The percentage of Fe and Cr was 90% in the residual fraction, which indicates the geological origin of these elements. Zn and Cu were also found in this fraction at percentages of up to 80%, implying that these metals were strongly bound to the sediments and will not be released under natural conditions. Similar distribution patterns of Zn and Cu suggest a common source or common fixation, transport and deposition mechanisms of these elements. Mn was found in the acid-soluble fraction at percentages of 40-50%. The high proportion of Mn in this fraction implies that Mn is bound to carbonates. Pb is the element showing the highest proportion (up to 60%) in the reducible fraction, especially in samples from the central part of the gulf indicating that lead is mainly bound to oxides. The metals studied can be ranked as follows according to the percentage of each in the first three fractions (the more mobile and bioavailable):Pb > Cd > Mn > Cu >Zn > Fe >Cr. A permanent monitoring system is needed in the gulf in order to discover any dangerous trends and avoid any harmful effects on the local ecosystem (including humans).

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