PREFACE

Special Issue “Geochemistry, Soil Contamination and Human Health. Part 2.”

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Background

This collection of papers submitted to this Special Issue is mainly an outgrowth from the Session ITS2.17/SSS12.2 EGU2020 “Geochemistry, soil contamination and human health: theoretical basis and practical approaches towards improvement of risk assessment”, Vienna, May 2020.

Human interaction with the environment has gone through several stages of evolution. Being a product of the natural evolution of living organisms in the biosphere, *Homo sapiens* as a species has evolved in the geochemical conditions of the virgin biosphere. The rapid development of intellectual abilities of this genus allowed, first, to survive in adverse environmental conditions around the whole world, then, to cultivate the land, transform the entire system of biocenoses, and now to create a new habitat exclusively for man. The result was a significant geochemical transformation of the virgin biosphere, but a kind of punishment for this progress was the emergence of several endemic diseases of a geochemical nature. Nowadays a variety of anthropogenic sources of pollution and their location in various natural geochemical conditions require not only constant monitoring of the chemical state of soil, water, air and food products but also the development of spatially

differentiated approaches to assessing the risk of provoked diseases.

This Special Issue contains 16 papers written by authors from 16 countries: Armenia, Australia, Brazil, China, France, Hungary, India, Iran, Lebanon, Pakistan, Portugal, Romania, Russian Federation, Sri Lanka, Spain and Vietnam.

In the following paragraph, I will summarize the content and main results of these papers published in this Special Issue. The order of papers is based on submission date.

Content and main results of the Papers of this Special Issue

Wang et al. (2022) investigated the association between haemoglobin (Hb) level and osteoporosis in a population with environmental Pb and Cd exposure (Yantou and Magu, Guizhou province, China). 194 women and 108 men with different levels of Cd/Pb exposure were included in this study. The Cd/Pb exposure was determined using graphite-furnaces atomic absorption spectrometry. Forearm bone mineral density (BMD) was determined by peripheral dual-energy X-ray absorptiometry. A logistic model was established to predict the rise of osteoporosis. Results showed that anaemia is a negative and independent risk of osteoporosis in men but not in women exposed to Cd and Pb. Age, Pb in bone and anaemia are important factors related to osteoporosis

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in men. A model based on the three factors showed acceptable performance in predicting osteoporosis.

Bulmau et al. (2022) compared the characteristics of biochar obtained by pyrolysis at six temperature levels ranging between 300 °C of two types of biomasses: agriculture-forest waste such rapeseed straw, poplar tree shavings from furniture making. Twelve biochars were generated by pyrolysis under low oxygen conditions of the selected biomasses in an electrically heated batch reactor. The authors evaluated the links between the type of feedstock, pyrolysis temperature and biochar Physico-chemical parameters. Results showed that both pyrolytic biochars have widely varying properties that escape characterization using parameters such as those provided by ultimate and proximate analysis. SEM images of the biochar revealed that an increase in temperature led to a higher porosity for PP biochar compared to RS biochar and that PP biochar pores tended to shrink with temperature.

Nikiforova et al. (2022) studied the main features and contamination of sealed soils in the east of Moscow city. The authors took 47 samples from 35 soil pits. Pollution of sealed soils with petroleum products (PP), benzo[a]pyrene (BaP) and heavy metal(oids), (HMMs) was evaluated. Sealed soils are characterized by the OM content (2,24%), alkaline reaction (pH 8), sandy loamy texture and the absence of soluble soils at the top of profile. The mean content of BaP in the sealed soils is 56 times higher than that in the background soils, it exceeds the maximum permissible concentration by 9.5 times. The concentrations of most HMMs in the sealed soils exceed the background level by two-four times. The most intense accumulation of As, Ba, Cr, Cu, Ni, Pb, Sb and Sn takes place in the industrial zone with a high degree of sealing. The hygienic standards for BaP and PPs content approved by the Russian Authorities in sealed soils of the Eastern Administrative District are exceeded by almost 10 times.

Chandran et al. (2022) assessed of water and soil quality of the Suruliyar sub-basin. In Tamil Nadu, India. The analysis revealed that the surface water parameters such as pH, EC, and total dissolved solids (TDS) were found to be within permissible limits of Indian Standards. The biological oxygen demand values show an increasing trend due to the anthropogenic activities on the riverside. Faecal coliform was present in the river water due human wastes are

entering the river water. Groundwater quality was assessed based on pH, EC and TDS values, which were normal, except for Jangalpatti Village. Groundwater is suitable for irrigation. Major nutrients such N were lower than the permissible limit, P was moderate and K, higher than the Standard limits. Dump-site and wastewater irrigation have increased the Mg content near the Cumbum and Jangalpatti areas. Na and Cl values were high in some areas. Most water quality parameters, indicating that treatment methods are not needed for drinking. But bacterial contamination can be managed using filters or boiling the water before drinking.

Tepanosyan et al. (2022) tested the adequacy of XRF and ICP-ES/ICP-MS aqua regia extractable (AR) results obtained for lab-type pre-treated samples for Ti, Fe, Mn, Co, V, Pb, Zn, Cu, Cr, Mo, Sr and As content in soils under the impact of Alaverdi copper smelter, Lori region, Armenia and assess the equality of PTE content induced health risk. Results suggested that XRF reached definitive data quality level for As, Zn and Mn and screening (quantitative) data quality level established for Cu, Pb, Fe, Mo, Cr, V, and Ti. At the same time, PTE induced health risk assessment at the established data quality level showed that equality of non-carcinogenic children's health risk was observed for As, Zn, Cu, Pb, Mn and V.

Egorova et al. (2022) researched the native culturable aerobic bacteria present in the sulphide ores in the deposits located in the Krasnoyarsk Territory, Russia and evaluated their activity in relation to O₂ and CO₂ present in air. The samples were collected from two deposits: N1, at depths of 60–500 m. and N2, at depths of 50–1000 m. The bacteria present in the N1 were related to genera *Bacillus* and *Paenibacillus* (class *Bacilli*), genera *Citricoccus*, *Micrococcus*, *Brachybacterium*, *Microcella*, *Dietzia*, and *Rhodococcus* (class *Actinomycetia*) and genera *Paracoccus* and *Pseudomonas* (class *Protobacteria*). The bacteria of the N2 were *Bacillus*, *Oceanobacillus*, (class *Bacilli*) and genera *Micrococcus* and *Agromyces* (class *Actinomycetia*). A relationship was established between the specific rate of O₂/CO₂ loss and specific growth rate of the bacterial communities. Thus, it was experimentally proven that the activity of bacteriocenosis present in the sulphide ore of the mines, considering the air exchange violations, can threaten the health of mining employees.

Nunes de Araujo et al. (2022) assessed the concentrations of As, Ba, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb and Zn as well as the fertility and texture of Cu tailings and soils of native, urban and pasture areas surrounding a copper mining complex in the eastern Amazon, Brazil. The authors calculated the contamination factor (CF), degree of contamination (Cdeg), potential ecological risk index (RI), geoaccumulation index (Igeo) and pollution load index (PLI). The levels of Co, Cu and Ni in the tailings exceeded the prevention and soil quality reference values, but the tailings area was considered unpolluted according to PLI and RI and presented a low potential ecological risk. For the urban and pasture areas, none of the eleven potential toxic elements analysed exceeded the prevention values established by the Brazilian Environmental Council.

Thakur et al. (2022) measured the activity content of the ^{226}Ra , ^{232}Th and ^{40}K in the soil along the Jwalamukhi thrust of Himachal Pradesh, North-Western Himalaya, India. The activity concentration of ^{226}Ra , ^{232}Th and ^{40}K for some of the soil samples, has been observed to be above the normal mean values. The indoor and outdoor effective dosages are well below the normal international and national proposed results. The determined values of external hazard (Hex) for studied locations are less than unity. The Ra equivalent activity was within the safe limits recommended by OECD. Soil of this area is recommended as construction material, but dwellings must be well ventilated.

Aminiyan et al. (2022) studied the potentially toxic elements (PTEs) contamination in topsoils around the copper smelter of Khatoonabad factory, Kerman province, SE Iran. The authors analysed the total concentration, chemical fractionation, and the mobility potential of As, Cd, Cr, Cu, Pb and Zn of 25 topsoil samples. Moreover, the spatial distribution of PTEs, the potential ecotoxicological and human health risks was assessed. The total contents of Cu, As, Cd, Cr, Pb and Zn, reaching up to 1478, 501.5, 21.6, 118.4, 573.5 and 943.3 mg kg⁻¹, respectively. The potentially available fractions after sequential extraction of these PTEs are very high. The spatial distribution of all PTEs indicated also very high values. The ecotoxicological status of the studied area, indicates high risks posed by the measured PTEs. Non-carcinogenic effects of As, Pb and Cu could adversely impact children's health. For adults only As can impact.

Li et al. (2022) investigated the distribution, source identification and contamination assessment of 8 potentially toxic elements (PTEs) in weathered waste rocks of Fushun Western Opencast Mine, Liaoning Province, NE China. The mean concentrations of Ni, Cr, Zn, Cu, Pb, Hg, Cd and As were 79.4, 86.3, 126, 64.8, 16.9, 1.04, 1.94 and 67 mg.kg⁻¹, respectively. These concentrations are not above the risk screening values of the standard, except for Cd, that for the Igeo values ranges from severe to extreme pollution, followed by Hg, which exhibits severe pollution. The mining area is moderately polluted, except for the coal gangue and self-combustion gangue (SCG) areas. Potential ecological risk that the mine is a moderate ecological hazard, and SCG is a serious ecological hazard. The health risk appears to be minimal and does not induce non-cancerous effects. Children were reported to be more vulnerable to PTE toxicity.

Natasha et al. (2022) researched the toxicity and tolerance/detoxification mechanisms of four levels of arsenic-induced oxidative stress in *Brassica oleracea* under hydroponic cultivation. Increasing As levels significantly decreased the pigment contents (up to 68%) of *B. oleracea*. Plants under As stress showed an increase in H₂O₂ contents (up to 32%) in roots while a decrease (up to 72%) in leaves because As is mostly retained in plant roots while less is translocated towards the shoot. Arsenic treatment caused lipid peroxidation both in the root and in leaf cells. Arsenic exposure (especially high level, 125 µM) causes pigment toxicity and oxidative burst in *B. oleracea*. The ability of *B. oleracea* to tolerate As-induced toxicity greatly varied with applied treatment levels (As-125 being more toxic than lower levels), plant organ type (more toxicity in leaves than roots) and physiological response parameter (pigment contents more sensitive than other response variables).

Balasooriya et al. (2022) investigated major and trace elements in rice soils in Sri Lanka with special emphasis on regions with endemic chronic kidney disease of undetermined origin (CKDu) that prevails in certain districts of the dry zone areas of Sri Lanka. A total of 102 rice soil samples were collected from the main wet and dry zones including CKDu hotspots. In most dry zones, adequate content of available P was recorded. Rice soil in the wet zones was acidic, with depleted Ca and Mg contents. Arsenic and Pb contents in soils were in CKDu regions. The enrichment factor revealed that soils in both dry and wet zones were

moderately enriched with As, Cd and Pb, but the Pb concentration was higher in the dry zone rice soils. Twenty per cent of the wet zone samples showed significant enrichment of Ni, Cu and Zn. Geoaccumulation index assorted that the studied soil samples were uncontaminated to moderately contaminated.

Arán et al. (2022) used combined tools for effectiveness evaluation of sulphide tailings of a uranium mine located at Saelices el Chico, Salamanca, Spain, rehabilitated with designed Technosol. After 20 months of the Technosol application, the tailing rehabilitation status (Rehabilitated tailing) was compared to a non-rehabilitated tailing (Tailing). To assess the rehabilitation, several properties were analysed: chemical characteristics of the materials and the leachates, soil enzymatic activities (dehydrogenase, β -glucosidase, acid phosphatase and urease, basal respiration and several plant endpoints from bioassays and pot experiment using *Lolium perenne* L. and *Trifolium pratense* L. Potentially toxic concentrations of Co, Mn and Ni were identified in available fraction and leachates. The improvement in the rehabilitated tailing materials allowed rapid plant cover with pasture species and suitable habitat for active microbial community. This improvement contributed to a decrease in ecological risk and the spread of hazardous elements.

Korobova et al. (2022) studied the spatial geochemical differentiation of the iodine-induced health risk and spatial distribution of thyroid cancer (THYC) amongst urban and rural population of the Central Russian Plain affected by the Chernobyl Nuclear Power Plant (NPP) accident. The authors characterized four regions of Russia by different content of stable I in soils and exposed to radioactive fallout of ^{131}I from the Chernobyl NPP. Using GIS technologies, zoning of territories for the deficiency of ^{127}I and pollution with ^{134}I was performed. The resulting risk maps were compared with the THYC distribution. The spatial distribution of the total (natural and anthropogenic) risk assessment and the incidence of THYC at the district level tended to have a higher positive correlation compared with the correlation of the latter parameter with a fallout density of ^{131}I . The correlation between the assessed total risk and THYC distribution in risk zones was significant and higher in the rural ones. A tendency for a negative significant correlation between daily I intake and THYC cases amongst rural populations was found.

Pham et al. (2022) evaluated the ecological risk related to contents of Zn, Pb, Co, Ni, Cr and Cu in the soil and eroded sediment samples from an organic vineyard Tokaj, NE Hungary. The contamination status and the ecological risk of target PTEs were assessed by calculating the contamination factor (CP), the pollution load index (PLI), the ecological risk factor (Er), and the ecological risk index (ERI). The median pollution load indices of 1.15, 1.81 and 1.10 for the topsoil, the sediments and the subsoil, respectively, indicate moderate multielement contamination, with PLI exceeding 1. Highest ER (3.36) observed for Cu in the sediment/ Cu in the topsoil revealing a preferential movement of Cu-rich soil particles by overland flow. The ERI (< 90) showed a low ecological risk in the vineyard. The highest Er (24.6) observed for the bioavailable Cu content in eroded sediment sample shows that Cu accumulation in sloping vineyards is an ecological risk, particularly in the sedimentation zones.

Feidt et al. (2022) assessed the efficiency of diverse amendments of a contaminated Nitisol by the pesticide Chlordecone (Kepone) (CLD) using two physiologically based approaches. A set of 5 carbonaceous materials (ORBO, DARCO, COCO CO 2, oak P1.5, Sargasso biochar, were tested and used to amend Nitisol at 2%. Bioaccessibility assessment was performed using Ti-PBET assay ($n = 4$). The relative bioavailability part involved 24 piglets randomly distributed into 6 experimental groups. All groups were exposed for 10 days via contaminated soil, amended or not with carbonaceous matrices. A significant decrease of relative bioaccessibility and CLD concentration in liver were observed for all amended groups in comparison to control group, except for the biochar amended soil in the bioaccessibility assay ($p < 0.05$). The largest reduction of transfer was obtained with commercial Activated Carbons (ACS) (90%).

Conclusions

The content of this Special Issue is of great importance and the 16 papers cover significant aspects of fundamental theoretical and applied research in geochemistry, soil contamination and human health and providing advances to the existing knowledge.

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