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Preface

Remediation of Polluted Soils - Part 3: Preface

The collection of papers presented in this special issue is an outcome of the SSS8.3 Session “Remediation of Polluted Soils” of the International European Geosciences Union (EGU) Conference held in Vienna, April 2015.

Soils are essential components of the environment, the basis of terrestrial ecosystems and a crossroad of biogeochemical cycles at the lithosphere-hydrosphere-biosphere-atmosphere interface. Therefore soils are a limited, precious and fragile resource, the quality of which should be preserved. However, the increased concentration and distribution of heavy metals, metalloids, radionuclides and organic xenobionts in soils by anthropogenic mismanagement of industrial and mining activities, overuse of agrochemicals, sewage and waste disposal cause contamination, environmental problems and health concerns. Hence, soil pollution needs innovative technologies of remediation.

This special issue contains 19 papers written by authors from 13 countries: Australia, Chile, China, Georgia, Germany, India, Iran, Italy, Japan, Peru, Poland, Russia and Spain. This collection of original studies focuses mainly on seven topics: 1) wastes as sorbing agents, 2) coal mine wastes, 3) radionuclides, 4) urban and peri-urban soils, 5) sequential fractionation, 6) distribution of metals, and 7) environmental risk assessment.

There are five papers dealing with the first topic, wastes as sorbing agents:

Lewinska et al. examined in a batch experiment the capacity of Fe-Mn wastes produced by water treatment plant for arsenic sorption and immobilization in highly contaminated soils from a former mining and processing. Application of increasing doses of Fe-Mn wastes to silt loam and sandy loam soils resulted in substantial decrease of As extractability. The presence of sewage sludge had apparently reverse impact on As solubility, and reduced the effect of immobilization particularly at lower rates of Fe-Mn wastes.

Bezuglova et al. studied the applicability of brown coal from Alexandria deposit (Ukraine) as sorbing and detoxifying agent of soils contaminated with heavy metals. Laboratory and field plot experiments have been conducted. Brown coal can be recommended as an ameliorant for soils contaminated with Pb, Zn and Cu. An empirical formula was proposed for the calculation of the most cost-efficient ameliorant rate.

Liu et al. evaluated the potential application of the hydroxyapatite derived from flue gas desulphurization gypsum for Pb and Cu adsorption in water and immobilization in soil. MINTEQ software was employed to determine the species distribution of Pb^{2+} and Cu^{2+} at different pH values. This study realized the potential of a modified geochemical waste material towards remediation of metal contaminated soils, providing useful information for other wastes such as paper sludge and phosphogypsum.

Lee et al. described the synergistic effect of As^{5+} and Sb^{5+} removal by magnetic nanoparticles supported layered double hydroxides (MLDH). The MLDH demonstrates effective removal capacity for As^{5+} and Sb^{5+} and the particles were rapidly separated from water. It has a potential for use in wastewater treatment.

Choppala et al. tested the effect of lime, elemental sulphur (S^0), Fe^{3+} oxide and cow manure on the retention capacity of Cr^{3+} and Cr^{6+} in contaminate soils. The authors found that the addition of lime increased the sorption of Cr^{3+} while S^0, Fe^{3+} oxide and cow manure increased Cr^{6+} retention. Therefore the mitigation of Cr toxicity is brought about, by the addition of amendments which manipulate the properties of soil to increase retention of Cr^{3+} and Cr^{6+}.

There is one paper concerned with the second topic, coal mine wastes:

Alekseenko et al. evaluated the environmental impact of disposal of coal mining wastes on soils and plants in Rostov Oblast (Russia). The soil samples were analyzed for mineral composition, particle-size distribution and gross contents of Cu, Zn, Pb, Ag, Sn, Mo, Ba, Co, Ni, Mn, Ti, V, Cr, Ga, P, Li, Sr, Y, Yb, Nb, Sc and Zr using emission spectral analysis. The plant species of mining influenced areas were described. The authors found that mining leads to soil destruction. The surface layers of the spoil tips are enriched in Mn, Cu, V, Cr, Zn, Pb, Mo and Ba, and also of oxidized pyrite, coal, chlorite, quartz, slag, hydromicas, gypsum, muscovite and kaolinite, that avoid the soil development.

Five papers cover the third topic, radionuclides:

Mishra et al. studied the vertical distribution of radio-caesium derived from the Fukushima-Daiichi Nuclear Power Plant accident in undisturbed soils of grass and forest. The authors found that the activity ratio for ^{137}Cs and ^{134}Cs was almost constant in soil profile as well as in the soil surface. Different soil parameters affect migration and migration velocity was found to be positively correlated with soil organic matter content and negatively correlated with the content of silicate minerals.

Jakhu et al. estimated the terrestrial radionuclide concentration and the effect of soil parameters on exhalation and emanation rate of radon. The results have shown that the exhalation and emanation rate of the ^{222}Rn,^{220}Rn from soil decreases as the grain-size increases and the porosity decreases. The high values of the ^{226}Ra and ^{232}Th radionuclides in soil samples are associated with the presence of granitic rocks. The ^{222}Rn exhalation and emanations are not only dependent on the ^{226}Ra content of the material.

Bangotra et al. determined the activity concentration of the natural radionuclides (^{226}Ra, ^{232}Th, ^{40}K) and Radon (^{222}Rn) exhalation rate in soil

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samples in the Barnala and Sangrur region of Punjab (India) using NaI gamma detector and scintillation based Smart Radon (^{222}Rn) Monitor. Soil samples used in the construction of dwellings were collected from different geologic formations of the same area. The ^{222}Rn exhalation rate varied from 16.9 to 38.2 mBq kg^{-1} h^{-1}. The overall average annual effective dose is lower than the world recommended value, hence without any radiological hazards to residents.

Korobova et al. studied the distribution and speciation of iodine (I) in drinking waters from geochemically different areas of Bryansk region contaminated after the Chernobyl accident in relation to health and remediation aspects. The authors found that drinking water was impoverished in I. The predominant form of I is iodide: CaI^{+}, CaI_2, MgI^{+}, MgI_2, that explains iodine concentration on carbonate barrier in soils and rocks. Iodine complexation may have contributed to radioiodine retention and the contaminated water filtration through soils rich in $CO_3^{=}$ and OM leads to radioiodine fixation. Also an inverse relation between of thyroid cancer and iodine content in dug well waters was revealed.

Rezza et al. carried out a geochemical survey to investigate the metal contamination in the Domizio Flegreo and Agro Aversano (Campania, Italy) and a Pb isotopic approach by means of soil, groundwater, human hair and corn samples. Pb isotope ratios were determined to identify the single sources of metals. The data were processed and mapped by ArcGis software to produce interpolated and contamination factor maps. The results show that Tl and V are of geological nature, and Hg, Ni, Se, Sb, Zn and Pb from anthropogenic activities, such industrial, illegal waste management practices and also related to pesticides (CRITTAM).

Three papers cover the fourth topic, urban and peri-urban soils:

Tume et al. investigated the spatial distribution of Cu, Pb and Zn in order to determine the degree of contamination in urban soils from Talcahuano (Chile). The authors found that the major factors controlling the variability of Cu, Pb and Zn concentrations in surface soils was the proximity of major roadways, emission sources and uncontrolled landfill sites. The background values were 43.7, 17.5 and 91.7 mg kg^{-1} for Cu, Pb and Zn respectively.

Tume et al. assessed the potentially hazardous element contamination in urban soils of Arica (Chile) using the geoaccumulation index (I_{geo}), enrichment factor (EF), contamination factor (C_f) and an integrated pollution index (IPI). The background values in mg kg^{-1} reported are: As 17.4, Ba 23.3, Cu 37.4, Ni 8.3, Pb 313, V 101 and Zn 235, which indicates a considerable contamination in the urban soils. The greatest Cu soil pollution was detected near the railway ore mineral transport. It is due to mineral particles falling during ore concentrate transport by train.

Guagliardi et al. analyzed the concentrations of vanadium (V) in urban and peri-urban soils from areas of Cosenza and Rende (Calabria, Italy). Statistical and geostatistical analyses of the distribution patterns of V in topsoil were used to identify the sources of pollution. Spatial distribution patterns showed that V was controlled by the parent material in peri-urban areas, particularly by ophiolites outcroppings. The urban soils were hardly affected predominantly by vehicle fuels.

Two papers in this special issue refer to the fifth topic, sequential fractionation:

Minkina et al. researched the transformation of Cu^{2+} ions in soils and mineral phases by the XRD, XAFS and sequential fractionation methods using a model laboratory experiment. It was found that the contamination of soil with a soluble Cu^{2+} salt increased the bioavailability of the metal and the role of organic matter and Fe oxides in the fixation and retention of Cu. The ion exchange processes result in the sorption of Cu^{2+} from the saturated solution by active sites on the internal surface of the lattice of dioctahedral aluminosilicates. The excess Cu^{2+} ions are removed due to the formation and precipitation of crystalline Cu $(NO_3)(OH)_3$.

Jalali and Latifi conducted a laboratory soil column study and a sequential extraction analysis to evaluate the effect of eight organic residues on retention and leaching of Cd, Ni and Zn in a calcareous soil. The authors found that application of manures and organic residues increased the potential for metals leaching due to their effects on pH and on dissolved organic carbon concentrations. Breakthrough curves of metals were simulated using PHREEQC program. The results indicated that leaching of Cd, Ni and Zn are mainly controlled by ion exchange and surface complexation reactions.

Two papers deals with the sixth topic, distribution of metals:

Samonova et al. analyzed concentrations and vertical distributions of Fe, Mn, Cu, Ni, Co, Cr, Zn, Pb, Ti and Zr in the coarse and medium sand fraction in the soils of the Russian plain. The authors attempt to establish the patterns of lateral distribution of the metals in the humus horizons of two catenas and two types of small erosional systems. The results imply that the vertical and lateral distributions of metals are controlled by the genesis of the sand fraction, chemical transformation by pedogenic processes and by lateral translocation of the soil material. The differentiation of metal contents revealed similar patterns in lateral distribution of Fe, Cu, Ni, Cr, Zr, Zn and different behaviour of Pb, Co and Mn.

Shipkova et al. studied the accumulation and distribution features of macro- and microelements in Luvisols of plain and mountainous regions. The authors found that the accumulation of microelements, Fe and Al in Luvisols of the mountainous regions such the Caucasian Reserve was higher than in the same soils of plain areas such the Polstovsky reserve. The accumulation of microelements by Luvisols is determined by the relief effect, parent rock, textures of soil horizons, percolative water conditions and, to a lesser extent, biogenic accumulation.

One paper refers to the seventh and last topic, environmental risk assessment:

Minolfi et al. conducted a regional approach to the environmental risk assessment in the Campania region (Italy). The authors followed the European PRA.MS guidelines, based on four different exposure routes: 1) dispersion of contaminants in groundwater, 2) dispersion in surface water, 3) dispersion in air, 4) direct contact with the contaminated soils. They used GIS software to evaluate 14 representative parameters, adopting a mixed additive and multiplicative algorithm, up to the overall risk score. The final risk map is classified according four classes of risk.

All these papers described above cover important aspects of fundamental and applied research and provide advances in relation to existing knowledge on Remediation of Polluted Soils.

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