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Editorial

Inorganic Pollutants into Groundwater: From Geochemistry to Treatment

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Geochemical approaches, including geochemical characterization and/or geochemical modelling of the environment of interest, represent a strong tool to predict the groundwater evolution as well as the release and fate of contaminants into peculiar geological setting [1–4]. Groundwater bodies in specific geologic environments for human activities (i.e., mines, geoparks and nature reserves, agricultural, residential, or industrial areas) have to be investigated in order to ensure a safe management of working, living, and tourist spaces, as well as to ensure the monitoring and protection of water resources and human health [5–9]. Geochemical characterization includes several practices of sampling and analysis types (i.e., analyses of major and trace of inorganic/organic compounds, isotopic and radiometric investigations), whereas geochemical modelling employs several softwares to predict the migration of pollutants in groundwaters [10]. These pollutants can reach high levels into groundwaters which are used for drinking or irrigation purposes worldwide, becoming hazardous for ecosystems and human health [11–16], mostly in developing countries [17]. Their mobility depends on several parameters, first of all the conditions of geochemical environment. Knowledge of natural or anthropogenic factors responsible for water contamination can be useful to develop efficient water remediation systems able to improve the living standards in the investigated environment, optimizing the decontamination process during the application on site [18–21] and achieving the standards of quality established by the World Health Organization (WHO) [22]. Several treatment technologies, both conventional and advanced, were employed to water decontamination, and among them, the membrane processes were considered valid remediation technologies for their multiple benefits [23–26].

For these reasons, the special issue is aimed at collecting methodological and multidisciplinary contributions that include geochemical and remediation approaches, to understand, monitor, and solve contamination issues with special focus on water resources. These studies represent a target tool for a successful policy management of water resources which can be applied by local authorities or can be viewed as guidelines to be applied in other geological setting.

C. Apollaro et al. studied the groundwater bodies of the Pollino National Park sites over northern Calabria and southern Basilicata regions (southern Italy) by using the reaction path modelling of rocks dissolution. Pollino National Park represents a precious resource to be protected and enhanced also by monitoring water bodies, which are essential for the biodiversity conservation.

The main lithotypes cropping out in the study area (i.e., limestone, Mg-limestone, dolomite, serpentinite, Al-silicate fraction of calcschist, and carbonate fraction of calcschist) were taken into account, evaluating the theoretical concentration of main and minor constituents dissolved during the water-rock interaction. The computed evolution trends reproduced satisfactorily the experimental data which are in agreement with the dissolution of pertinent lithotypes. Furthermore, the water-quality check allowed to establish that the detected levels of potential harmful pollutant, like Al, Cl, F, NO_3, and SO_4, are below the limit values fixed by the WHO.

An important aspect of natural/anthropogenic contamination is the level of radioactivity into the environment, since the level of radiation constitutes a potential risk to human health. I. Guagliardi et al. investigated the equivalent dose rate of natural radionuclides (H_T) in several springs and surface soil samples coming from the Crati basin in the Calabria region (Southern Italy). The results pointed out that the highest H_T values were recorded in soil samples originating mainly from igneous-metamorphic rock alteration. Indeed, these rocks are constituted by minerals containing K, U, and Th, which represent naturally occurring radioactive elements. Likewise, the equivalent dose rates of waters well fit the elemental distribution of the same lithologies. The detected equivalent dose, nowadays, not evidence serious health risks, however the long exposure time can represent an hazardous factor for people living in surrounding area.

Geochemical characterization of waters in areas affected by agricultural and industrial activities is part of geochemical application for the groundwater quality assessment and resource management. M. Paternoster et al. investigated the quality of groundwaters in High Agri Valley (Southern Apennines, Italy) studying the chemical features of several springs and wells by coupling the hydrogeochemical investigation with multivariate statistic, saturation calculation, and isotopic information. The latter revealed a meteoric origin, whereas the results of analyses pointed out that the water-rock interaction process is the main factor influencing the water chemistry, except for few samples characterized by high SO_4^{2-}/NO_3 ratio probably due to an anthropogenic input. The results were also compared with threshold values reported by the WHO and the Italian legislation, highlighting that the studied waters are suitable for drinking and irrigation purposes, although the medium to high salinity detected can represent a potential risk for agricultural practices.

The geochemical approach coupled with numerical modelling can be applied in different fields of environmental sciences, including the management of workspaces like mines. For instance, X. Du et al. proposed an environmental evaluation model to create an objective, convenient, and precise tool applicable in coal mines. The model was based on generalized linear theory and fuzzy analytic hierarchy processes. The water quality was considered as an index factor to insert for a proper environment evaluation. Indeed, the generalized linear theory allowed to obtain the importance degree of each index factor like water, air, soil, ecological compensation, and other indexes affecting the quality of these environments. Afterwards, through the logarithmic fuzzy preference programming method, the influence of each considered index factor was accurately calculated, reducing, thus, the impact of subjectivity of the expert evaluator concerning the environmental evaluation of working spaces.

Monitoring of water quality in protected, working, and residential areas is on the basis of a correct water resource management; however, the development of new technologies for water decontamination represents the current challenge worldwide. In this trail, S. H. Ahmed et al. investigated the performance of three polyethersulfone membranes (PES1, PES2, and PES3) to evaluate the rejections of Co^{2+}, Cd^{2+}, and Pb^{2+} ions, which can reach high levels into groundwaters due to water-rock interaction processes and/or anthropogenic inputs. The experiments were performed using binary and ternary solutions containing different pollutant ratios. Co^{2+}, Cd^{2+}, and Pb^{2+} ions were well-rejected in binary solutions when their initial concentration was lower than the initial concentration of the other ion present in the same binary solution. Concerning the ternary solutions, the rejections were higher when the initial level of the pollutant into the solution was lower. Generally, the following rejection tendencies were observed: $Co^{2+} > Cd^{2+} > Pb^{2+}$. Summing up, the research provided satisfactory results concerning the decontamination of solution and the methodology can be applied in the future to solve groundwater pollution issue in areas affected by high levels of these contaminants.

Conflicts of Interest

The guest editors declare that they have no conflict of interest.

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