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Editorial

The Role of Water-Rock Interaction Processes in Soil Formation: Geochemical, Mineralogical, Geomorphological, and Engineering-Geological Aspects

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The abundance and mobility of minor and trace elements and the thermodynamic considerations on water-rock interaction processes are important in order to characterize the weathering processes affecting the rock masses. The tectonic conditions play a key role for the water circulation in the ground. Thus, the combination of the tectonics of an area with its climatic conditions (in terms of rain amount and types) influences the chemical, mineralogical, and physical transformations of rock masses occurring during weathering processes [1–4]. These changes further affect the stability of rock masses with a considerable decay of their physical-mechanical properties and, thus, can result in the onset of adverse geomorphological consequences [5]. In particular, pedogenetic alteration processes weaken the rock producing thick sequences of weathered materials (residual soils such as saprolites) and a reduction of mechanical properties—due to cycles of wetting-drying, softening, and infiltration of different aqueous solutions—making slopes vulnerable to landslides [6–8]. An in-depth characterization of geotechnical properties and soil thickness may lead to correct decisions in land management, soil erosion estimation, shallow landslide susceptibility assessment, and the design of risk mitigation countermeasures [9, 10]. Moreover, when weathering affects rocks, some naturally occurring potentially harmful elements (e.g., Cr, Ni, Co, and V) become enriched in soils [11, 12]. In turn, these elements may be extracted from soils and may be concentrated in plant tissues, leading to either their further dispersion in the environment or possible phytoextraction uses. The qualitative interpretation of these phenomena is often insufficient for understanding pedogenetic processes and other processes of interest. Consequently, it is advisable to simulate these processes by geochemical modeling [13, 14], thanks to the availability of both laboratory measurements of dissolution rates for several minerals including silicates, oxides, hydroxides, carbonates, sulphates, phosphates, and sulfides and sufficiently complete and accurate thermodynamic data for numerous minerals, aqueous species, and gases.

This special issue solicits methodological contributions and multidisciplinary case studies on all the aspects of water-rock interaction in soil formation and specifically on the analysis and modeling of pedogenetic alteration processes, also in relation to the chemical characteristics of percolating waters feeding groundwater reservoirs, authigenic solid phases, and the underlying bedrock.

Given the above scenario, the call for papers for publication in this special issue, which was launched in October 2017, is aimed at considering methodological contributions and multidisciplinary case studies on all the aspects of water-rock interaction in soil formation and specifically

on the analysis and modeling of pedogenetic alteration processes, also in relation to the chemical characteristics of percolating waters feeding groundwater reservoirs, authigenic solid phases, and the underlying bedrock.

Potential topics of this special issue included but were not limited to

(i) geochemical modeling of soil processes

(ii) groundwater and soil water geochemistry

(iii) environmental geochemistry

(iv) climatic variations

(v) rock-forming minerals containing potentially harmful elements

(vi) weathering formation processes and rates and landscape evolution

(vii) soil erosion

(viii) weathering profile characterization and mapping

From mid December 2017 to late June 2018, a total of 10 papers have been submitted to be considered for publication in the special issue. After rigorous editorial check and peer-review processes which involved external and independent experts in the field, 1 paper was rejected, 1 paper has been withdrawn, and 8 papers have been accepted, with an acceptance rate of 80%. 39 authors from 3 different continents (South America, Europe, and Asia) contributed to the special issue.

In the paper "Groundwater-Mixing Mechanism in a Multiaquifer System Based on Isotopic Tracing Theory: A Case Study in a Coal Mine District, China," P. Huang and X. Wang through a geochemical and isotopic study evaluate the mixing characteristics of various types of groundwater and determine the sources of groundwater and their mixing mechanism in the main aquifers in an environment where the degree of coal mining is becoming increasingly serious.

In the paper "Study of the Corrosion Characteristics of Tunnel Fissures in a Karst Area in Southwest China," Y. Zhao et al. establish the numerical model of the Wulong tunnel (study area) to quantitatively analyze the corrosion range, corrosion ratio, and changes in the permeability and porosity of the fissures in soluble rock of karst areas of the tunnel over the past 100 years. The obtained results, verified by field experiments, show that the main controlling factor of the fissure corrosion of the tunnel in the karst area is the flow rate. The opening of the dead-end pores greatly enhanced the permeability and slightly increased the porosity, which caused the differential corrosion of fissures in the karst area. The simulation model can be used to quantitatively predict the corrosion evolution of a fissure zone within the acceptable range of error.

In the paper "Study on the Law of Membrane Efficiency of Unsaturated Shale and Its Application," L. Chang et al. highlight that the microscopic interaction mechanism between working fluids and shale reservoirs is the key basic issue for the efficient development of shale gas. In this paper, the characteristics of shale water saturation are considered. The model calculating membrane efficiency is obtained, and the shale membrane efficiency of the reservoir studied, based on the triple-layer model of clay mineral-water interface electrochemistry. Membrane efficiency of unsaturated shale depends on the excess charge density of the surface of the solid in different water saturations. The analysis of factors influencing shale membrane efficiency in unsaturated reservoirs shows that the shale membrane efficiency decreases with the increase of water saturation under unsaturated conditions. The partition coefficient of counterion in the Stern layer, cation exchange capacity, and solute concentration in pore fluid will affect the membrane efficiency of unsaturated shale. The membrane efficiency of the reservoir section shale in Fuling area is calculated and analyzed, and the water-absorbing capacity by chemical osmosis of the reservoir interval shale is evaluated based on the membrane efficiency model of unsaturated shale.

In the paper "Effects of Initial Porosity and Water Pressure on Seepage-Erosion Properties of Water Inrush in Completely Weathered Granite," L. Jinquan et al. used a self-designed large-scale triaxial testing system in order to investigate the effects of water pressure and initial porosity on the mass transfer and flow properties in completely weathered granite. The results indicate that the particle transfer could cause an increase in porosity, permeability, and water inflow, which is the essential reason for water inrush in completely weathered granite. Moreover, due to the effect of particle transfer, the flow properties may change from a Darcy to non-Darcy flow, which is a key signal for water inrush. Finally, with the increasing of water pressure, the transfer mass, permeability, and water inflow increased gradually, and a critical value that caused the water inrush was obtained. Furthermore, with the decreasing of initial porosity, the mass transfer and flow properties were suppressed rapidly, and a critical porosity to anti-inrush was observed.

In the paper "Feldspar Dissolution and Its Influence on Reservoirs: A Case Study of the Lower Triassic Baikouquan Formation in the Northwest Margin of the Junggar Basin, China," M. Xiao et al. investigated feldspar dissolution in the Baikouquan Formation in the northwestern margin of the Junggar Basin (China). Results show that the content of feldspar is high in the conglomerate reservoir of the Baikouquan Formation and that feldspar dissolution in the subaqueous distributary channel of a fan delta plain significantly improves the properties of the reservoir. The authors also evidenced that the strength of feldspar dissolution increases with depth but varies in different sedimentary environments and that in the subaqueous distributary channel, the content of rigid particles, such as quartz and feldspar, is high and has better sorting and higher original physical properties.

In the paper "Geochemical Characterization of Spring Waters in the Crati River Basin, Calabria (Southern Italy)," S. Gaglioti et al. showed the results of a qualitative analysis on about 200 samples of spring waters collected in

the largest catchment of the Calabria region (southern Italy). In particular, several physical and chemical parameters were analyzed and the Langelier-Ludwig diagram was built to evaluate the hydrochemical facies of the sampled waters. Results showed a good quality status of the spring waters in the Crati basin, with a predominant Ca-Mg type hydrochemical facies. Moreover, some peculiarities have been highlighted, in particular, in the Pollino Massif and Mt. Cocuzzo areas which showed high concentrations of almost all the investigated parameters. Finally, through the application of a geostatistic approach, the sampled data were spatially distributed, thus allowing a global overview of the hydrochemical state of natural water springs in the basin.

In the paper "Geothermal and Mineralogic Analysis of Hot Springs in the Puracé-La Mina Sector in Cauca, Colombia," D. A. Torres-Ceron et al. through a geochemical study of several thermal sources at the Puracé-La Mina sector (Cauca, Colombia) strengthen and determine the potential applications of those thermal waters also in order to contribute to enhance the continental tourism in Colombia. In this work, the authors develop a broad study of several characteristics that allows classifying a great quantity of thermal sources in the Puracé-La Mina sector (Cauca, Colombia) in order to find more suitable applications. The physicochemical analyses show that most of the sources have a sulfated-acid nature which makes them heated vapor waters and volcanic waters, whereas the mineralogical analyses of the rocks exposed to water interaction are mainly characterized by high content of silica isomorphous minerals. This work further shows that these thermal sources are immature waters and still do not reach chemical equilibrium, indicating that the sources have not sufficiently interacted with the rocks.

In the paper "Research on Stability of an Open-Pit Mine Dump with Fiber Optic Monitoring," T. Zhigang et al. propose monitoring the stability of Dump II within the Nanfen Open-Pit Iron Mine, located in Northeast China, using the fiber optic sensing technology. To pursue this aim, the authors firstly propose a physical model similarity ratio according to the on-site engineering geological survey data. The governing principles of deformation in the shallow dump layers in terms of different heaped loads and rainfall were then determined using fiber optic sensing to conduct an experimental study on the monitoring of the dump stability with an indoor physical mode. Finally, the FLAC3D method was used to simulate the deformation features in the shallow part of Dump II under different heaped load conditions and verify the experimental results of the indoor physical model. The obtained results provide the scientific basis for stability monitoring of similar dumps by detecting the early warning signs of instability phenomena.

Conflicts of Interest

The guest editors declare that they have no conflicts of interest or private agreements with companies.

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