Contaminant Geochemistry

Interactions and Transport in the Subsurface Environment

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Part I
Geochemistry Revisited: Selected Aspects

We conceived this book on contaminant geochemistry not only for researchers in hydrology, soil science, and geochemistry but also for advanced undergraduate and graduate students in environmental sciences and various specialists working on environmental pollution problems. As a consequence, we consider it useful and necessary to include introductory material that presents a short characterization of porous media together with selected geochemical processes. Part I characterizes subsurface components and the geochemical pathways and processes related to potential contamination. Keeping in mind that contaminant geochemistry covers a diverse range of natural and human-induced processes, we have selected only those that are most relevant to our field of interest.

The first chapter presents the porous medium solid, liquid, and gaseous phases in an environment controlled generally by fluctuations of rainy and dry periods, reflected by a variety of saturated and partially saturated conditions. A description of mineral and organic components in porous media is followed by a discussion of the electrically charged surface properties that affect the near solid phase water. The composition of the subsurface water solution as affected by the surrounding solid phase, by the natural biological environment, and possibly by human factors also is discussed. The gaseous composition of porous media, which affects the chemistry of the liquid phase, is another part of the subsurface environment. Consideration of the aquifer environment, characterized by a saturated regime, includes a brief discussion of groundwater geology and composition.

Selected geochemical processes that relate to the behavior of contaminants in the subsurface are described in the second chapter. We focus on thermodynamic considerations and equilibrium processes in the subsurface, accounting for interactions among solid, liquid, and gaseous phases. Kinetic considerations in defining the solubility of organics and minerals, as well as knowledge of chemical potentials, ion activities and reaction rate laws, also are included. The weathering of subsurface solid phases, which occurs as a result of interactions with the liquid phase, is a natural geological process that may be accelerated by anthropogenic influences. Dissolution-precipitation and redox mechanisms are other important processes affecting subsurface weathering that are included. The solid phase is a potential contaminant adsorbent, and we therefore consider adsorption as a main geochemical pathway, relevant in defining the retention, release, and persistence of pollutants in the subsurface.