Preface to the First Edition

Contaminant Geochemistry: Interactions and Transport in the Subsurface Environment combines the earth science fields of subsurface hydrology and environmental geochemistry and aims to provide a comprehensive background for students and researchers interested in protection and sustainable management of the subsurface environment. This book focuses on the upper part of the earth's crust, covering the region between the land surface and the groundwater zone; anthropogenic contamination occurs primarily in this well-defined geosystem.

Water and land are limited natural resources, and it is incumbent on humankind to manage knowledge and technology in a way that avoids, or at least minimizes, deterioration of these resources. In this context, an understanding of the interactions between subsurface components (solid, liquid, and gaseous phases) and chemical contaminants is required. Because the subsurface is an open system, contaminants may be transported, transformed, and redistributed in the subsurface under a variety of environmental influences. Contaminant interactions in the subsurface are subject to continuous changes, being affected by fluctuations in climatic conditions (particularly precipitation) and microbiological activity. Additionally, these interactions are controlled by the structure and properties of the earth materials, the molecular properties of the contaminants, and the hydrogeology of each specific location. As a consequence, a multidisciplinary approach is fundamental to understanding the governing processes.

Because our book was conceived for readers with different backgrounds, we devote Part I to revisiting aspects of classical geochemistry, focusing on the constituents of subsurface water and earth materials (Chapter 1) and selected processes related to potential interactions between subsurface liquid and solid phases with toxic chemicals (Chapter 2). Part II is an overview of potential subsurface contaminants of anthropogenic origin; properties of these chemicals are described together with their environmental hazards. Chapter 3 is devoted to inorganic chemicals, while the characteristics and hazards of organic toxic chemicals are presented in Chapter 4.

The retention of contaminants in the subsurface, controlled by properties of both chemicals and subsurface constituents as well as contaminant partitioning among the solid, aqueous, and gaseous phases, are the focus of Part III. Chapter 5 deals with the sorption, retention, and release of contaminants, while Chapters 6

and 7 examine contaminant partitioning in the aqueous phase and partitioning of volatile compounds.

Contaminant redistribution in the subsurface, as a result of transport (in dissolved form, as an immiscible-with-water phase, or adsorbed on colloids) is discussed in Part IV. These phenomena do not occur in a static domain, and contaminants are redistributed, usually by flowing water, from the land surface, through the partially saturated subsurface down to the water table, and within the fully saturated aquifer zone. After a basic presentation of water movement in the subsurface environment (Chapter 9), we focus on transport of passive contaminants (Chapter 10) and reactive contaminants (Chapter 11).

Transformation and reactions of contaminants in the subsurface are addressed in Part V. From an environmental point of view, we do not restrict the contaminant transformation to molecular changes; we also consider the effects of such changes on contaminant behavior in the subsurface. Abiotic and biologically mediated reactions of contaminants in subsurface water are discussed in Chapter 13. Abiotic transformations of contaminants at the solid–liquid interface are described in Chapter 14, while biologically mediated changes in subsurface contaminants are the subject of Chapter 15.

We used our own results and selected research findings reported in the literature to provide numerous examples of contaminant retention, redistribution, and transformation in the subsurface (Chapters 8, 12, and 16). Because a limited number of published research findings had to be selected from the vast number of available publications, the choice was very difficult. Many other research results of equal value could have been used to illustrate processes governing the fate of contaminants in the subsurface environment.

Contaminant Geochemistry was written for the use of geochemists, soil scientists, water specialists, environmental chemists, and engineers involved with understanding, preventing, controlling, and remediating subsurface contamination by chemicals of anthropogenic origin. This book also provides beginning graduate students in environmental sciences an overview of contaminant behavior in the geosystem, as a basis for their future professional development. We hope that we have succeeded in presenting the reader with a comprehensive—but not exhaustive—review of current knowledge in the field of subsurface contaminant geochemistry.

Rehovot, Israel, June 2007

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Preface to the Second Edition

We were pleased when the publisher asked us to prepare a second edition of "Contaminant Geochemistry: Interactions and Transport in the Subsurface Environment," as a result of the strong interest in our book published in 2008. This book focuses on the upper part of the earth's crust, covering the region between the land surface and the groundwater where anthropogenic chemical contamination primarily occurs.

In this expanded second edition, new literature has been added on contaminant fate in the soil–subsurface environment. In particular, we have included more data on the behavior of inorganic contaminants and on engineered nanomaterials, the latter comprising a group of "emerging contaminants" that may reach the soil and subsurface zones. To facilitate access to the cited literature in this second edition, we include the references after each chapter. We have also introduced corrections to small errors in the first edition.

Part VI of the book is devoted to a new perspective of contaminant geochemistry, namely irreversible changes in pristine land and subsurface systems following chemical contamination. Two new chapters were added on this topic, focusing attention on the impact of chemical contaminants on the matrix and properties of both liquid and solid phase of soil and subsurface domains. Contaminant impacts on irreversible changes occurring in groundwater are discussed in Chap. 17 and their irreversible changes on the porous medium solid phase are surveyed in Chap. 18. In contrast to the geological timescale controlling natural changes of porous media liquid and solid phases, the timescale associated with chemical pollutant-induced changes is far shorter and extends over a "human lifetime scale."

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