
This book presents the important fundamental concepts and current knowledge related to the mineralogy of soils and sediments, with specific reference to their roles in environmental quality and relevant processes. The stated target audience is students and others, from all disciplines, with a professional interest in soil mineralogy.

The book has 28 chapters that can be divided into three general categories: Chapters 1 through 5 give an overview of the basics of mineralogy, the chemistry of soil minerals, and methods of analysis; Chapters 6 through 22 cover the various groups of minerals themselves; and Chapters 23 through 28 generally relate to the kinds of environments in which soil minerals occur and their roles in some specific environmental quality issues.

More specifically, Chapter 1 (An Introduction to Soil Mineralogy) introduces the chemical and structural classification of minerals, with more detail on the structures of phyllosilicates, zeolites, and allophane and imogolite. It also gives a brief overview of crystallographic concepts. Chapter 2 (Surface Chemistry of Soil Minerals) covers the chemical reactivity of soil particles and the surface chemistry of the soil–water interface. Chapter 3 (Soil Organic Matter and Organic–Mineral Interactions) describes the chemical nature of soil organic matter and how soil organic compounds interact with soil minerals. In Chapter 4 (Mineral Equilibria in Environmental Soil Systems), the principles of thermodynamic equilibrium models and steady-state kinetic models are explained with reference to soil mineral systems, with specific discussions of mineral weathering, soil fertility and plant nutrition, acidic deposition, groundwater quality, and environmental pollutants. Chapter 5 (Methods for Determination of Mineralogy and Environmental Availability) describes strategies for identifying and quantifying soil minerals and trace elements of environmental interest. It introduces the concepts of sample fractionation, total elemental analysis, nondestructive elemental analysis by X-ray spectrometry techniques, electron microscopy, X-ray diffraction, vibrational spectroscopy, X-ray absorption spectroscopy, optical microscopy, thermal analysis, methods of determining redox state and surface properties, and selective dissolution and differential analysis techniques. Figures in this chapter clearly illustrate the principles, experimental setup, and typical outputs of the various analytical approaches, and summarize their advantages and disadvantages.

The chapters on the minerals themselves (Chapters 6–22) are organized in a consistent style covering structure, composition, and morphology; chemical and physical properties; abundance, distribution, and formation; environmental significance; and identification and quantification. Many of the chapters also include sections on future research needs, case studies, questions and exercises for students, and a glossary of specialized terms. The case studies are particularly helpful in bringing the principles to life, and it would have been nice to have even more of them. The minerals covered in these chapters are carbonates and evaporites, sulfides and sulfates, aluminum hydroxides, allophane and imogolite, iron oxides, manganese oxides, kaolins, serpentine minerals, pyrophyllite and talc minerals, micas, smectites, vermiculites, chlorites, palygorskite and sepiolite, zeolites, silica minerals, phosphate minerals, and titanium and zirconium minerals. Included throughout these chapters are beautiful color plates illustrating mineral structures and figures with electron micrographs showing mineral morphologies. The iron oxide chapter, in particular, has plates showing the characteristic colors of the various mineral species and colorful soil and environmental features involving iron oxides.

In Chapter 23 (Soil Minerals, Their Geographic Distribution, and Soil Taxonomy), the use of mineralogy as a criterion in the USDA soil taxonomic system is thoroughly explored. The mineralogical context of each of the 12 soil orders is discussed, and the soil mineralogy family classes are reviewed. Beautiful small-scale color maps showing the distribution of soil mineralogy families in the United States are presented. A discussion of the environmental implications of each of the soil mineralogy classes should be useful to those using soil survey databases and needing to understand the implications of soil mineralogy at the mapped scale. Chapter 24 (Mineralogy and Soil Tectonics) addresses the use of soils in evaluating the tectonic history of specific sites, such as those proposed for construction projects (e.g., nuclear power plants, dams, buildings). While much of this important environmental application relies on soil morphology, soil mineralogy does come into play. Chapter 25 (Radionuclide-Contaminated Soils: A Mineralogical Perspective for their Remediation) introduces the concepts of radioactivity and the origin, extent, and behavior of common radionuclides in soils. The mineralogical properties related to contaminated soil remediation and the selection of appropriate technologies for remediation are covered. Chapter 26 (Reactions of Pesticides with Soil Minerals) covers the basic principles governing pesticide–mineral interactions and addresses those interactions for specific classes of pesticides. This is an important topic given the huge quantities of pesticides applied to soils each year. Chapter 27 (Interactions of Enzymes with Clays and Applications in Bioremediation) describes how the interaction between clays and enzymes affects enzymatic activity and stability. Clay-immobilized enzymes are finding effective applications in catalyzing the biodegradation of pollutants and as chemical sensors for rapid, inexpensive detection of contaminants in soil and water. The final chapter (Charcoal in Soils: A Preliminary View) deals with an often ignored soil component that has great promise for increasing our understanding of paleoenvironmental conditions and the current environmental functioning of soils.

Comparison of this book with its outstanding precursor, Minerals in Soil Environments (Dixon and Weed, 1989) is inevitable. This book is not so detailed in its treatments as the earlier book, which was targeted toward soil scientists, but it covers the basics very well and provides up-to-date coverage of every topic with current literature citations. Essentially, rigor relative to mineral structure, composition, and chemistry was sacrificed to expand on environmental applications. The use of color figures is impressive in the new book, helping to illustrate mineral structures and clearly showing field occurrences. While Minerals in Soil Environments was found on the bookshelf of most practicing soil scientists, Soil Mineralogy with Environmental Applications should be even more widely appreciated. I recommend it to all soil scientists, hydrologists, geologists, and other environmental scientists, who will all find it to be a valuable resource. It will also be an effective text for teaching soil mineralogy. Overall this is an exceptionally well-prepared book.

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