Introduction to the Biogeochemistry of Soils

This is the first process-based textbook on how soils form and function in biogeochemical cycles, offering a self-contained and integrated overview of the field as it now stands for advanced undergraduate and graduate students in soil science, environmental science, and the wider Earth sciences. The jargon-free approach quickly familiarizes students with the field’s theoretical foundations before moving on to analyze chemical and other numerical data, building the necessary skills to develop questions and strategies for original research by the end of a single-semester course. The field-based framework equips students with the essential tools for accessing and interpreting the vast United States Department of Agriculture soil data set, allowing them to establish a working knowledge of the most important modern developments in soil research. This textbook is complete with numerous end-of-chapter questions, figures, and examples, and students will find it a multidisciplinary toolkit invaluable for their future careers.

Ronald Amundson has spent his career at Berkeley working to integrate and expand an appreciation of soils within the earth sciences. By utilizing principles of isotope geochemistry, he has developed isotopic tools for environmental and paleoclimate studies, and helped develop new methods of dating soils and landscapes. He has nearly two decades of research experience in the Atacama Desert of Chile, exploring the climate threshold between the biotic and abiotic regions on Earth, and how this can ultimately inform us about the history of our planetary neighbor, Mars. Amundson is an elected fellow of the Soil Science Society of America and the American Geophysical Union.
Introduction to the Biogeochemistry of Soils

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University of California, Berkeley
In memory of my parents, Merle and Ethel, and my sister Susan.

And is it so hard to believe that souls might also travel those paths? . . . That great shuttles of souls might fly about, faded but audible if you listen closely enough?

*Anthony Doerr – All the Light We Cannot See*
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Preface

Soil is now in the midst of an enormous increase in scientific recognition and interest due to its central importance to the challenging societal and global issues of climate change and food production. New soil biogeochemical theories and models in the past few decades, combined with easily accessible data sets, make understanding soil processes at the local to the global scale accessible not only to researchers but to students. However, much of the recent evolution in soil biogeochemical theory, or applications of models from other fields to soil biogeochemistry, is not available in a comprehensive manner in most books. One must largely access the primary peer-reviewed literature in order to learn about these methods and how they can be applied to specific questions. Thus, the purpose of this book is to serve as an introduction to recent developments in concepts and models of soil processes, and to the array of soil chemical and physical analyses that are now widely available. The book also applies the various concepts and tools to specific examples. Most importantly, the primary objective is to reveal how the reader might use this book as a starting point to address questions and problems of their own and advance the field through their own unique work.

Biogeochemistry, as the name indicates, spans biotic to abiotic chemical properties and processes. Here, the focus is largely on the soil solid phase and on the organic and inorganic compounds that comprise it and that undergo changes mediated by an array of complex mechanisms. Specifically, the focus is on soil processes occurring in situ on the landscape, with a view of soil as a functioning physical body exchanging matter and energy with its surroundings. This focus of observation then helps define and restrict the types of processes, and models to describe them, that are explored here.