Geochemistry, Groundwater and Pollution. C.A.J. Appelo and D. Postma A.A. Balkema Publishers, Leiden, The Netherlands. 2005. 2nd Ed. (xviii + 649 pages). $ 43.95 in paperback (ISBN 04 1536 428 0)

This book presents important fundamental concepts and current knowledge of groundwater geochemistry and the interaction of water, minerals, gases, pollutants, and microbes. It is an update of the first edition published in 1994. The book is intended to be used as a textbook and as a reference. Groundwater geochemistry is treated in a very comprehensive manner, providing detailed explanation of fundamental concepts, as well as extensive real world applications. The book contains eleven chapters that fall broadly into three general topics: 1) introduction to groundwater geochemistry, flow and transport; 2) chemical processes; and 3) numerical modeling. Many case studies of environmental interest are described. Chemical theory is not presented for its own sake but is discussed as needed for solving specific problems. All chapters contain an extensive set of problems with answers. Therefore, I would expect it to have wide-spread utility for students, instructors, and practitioners, alike.

More specifically, Chapter 1 (Introduction to Groundwater Geochemistry) introduces the concepts of groundwater quality. Chapter 2 (From Rainwater to Groundwater) describes the hydrologic cycle, rainwater composition, and isotopic composition. Chapter 3 (Flow and Transport) treats water flow in saturated and unsaturated zones and the physical processes of diffusion and dispersion.

The majority of the book is devoted to the description of various important geochemical processes. Chapter 4 (Minerals and Water) comprehensively describes the basics of equilibrium chemistry and kinetics including the topics of solubility, solid solutions, activity coefficient expressions, and rate laws. The mineralogy, aqueous chemistry and isotope chemistry of carbonates is discussed in Chapter 5 (Carbonates and Carbon Dioxide). The fact that a separate chapter has been devoted to these minerals highlights their importance and facilitates understanding of their complex chemistry by the reader. Chapter 6 (Ion Exchange) treats the principles of ion exchange in aquifers and soils. A small section on double layer theory seems a bit lost in this chapter. Chapter 7 (Sorption of Trace Metals) describes variable charge, sorption, and surface complexation modeling. I found the almost exclusive focus on metals to be disappointing. This chapter could have been broadened considerably by inclusion of material on anion sorption. In Chapter 8 (Silicate Weathering) the authors again focus on a specific mineral group whose reactions have great environmental importance. Chapter 9 (Redox Processes) treats oxidation and reduction processes starting with basic theory. This chapter is highly informative, describing many redox couples and diverse environmental systems where redox processes are important. Chapter 10 (Pollution by Organic Chemicals) rounds out the chemical processes section by describing the hazards of organic contaminants as they leach, sorb, transform, and decay in the environment.

The final sections of the book include Chapter 11 (Numerical Modeling) and Appendix A (Hydrogeochemical Modeling with PHREEQC). Chapter 11 introduces numerical modeling of transport and provides real world examples such as toluene degradation, remediation of BTEX pollution, acid mine drainage, and arsenic contamination in Southeast Asia. Appendix A lists input files to allow the reader to commence with using the computer program PHREEQC for geochemical modeling.

A unique feature of the book is its heavy reliance on use of the PHREEQC program. The authors use this code to elucidate complicated chemical concepts and to analyze the interactions between chemical and transport processes. Numerous examples show PHREEQC applications with input files listed directly in the text. I would expect such examples to be highly useful as teaching tools in the classroom. The practitioner interested in simulating field and laboratory data to solve specific problems would also be well served with these examples. As a research scientist, I found the book's exclusive treatment of only one model to be a bit disconcerting. Has the PHREEQC code taken over the field to such an extent that no other model is worthy of even being mentioned? Perhaps PHREEQC has become the standard of the industry, but mention of WATEQ, MINTEQ, HYDROGEOCHEM, HYDRUS, and UNSATCHEM to name just a few, would have been helpful. The authors could have then pointed out the perceived advantages of PHREEQC over the other programs.

Overall, this book (which I did read cover to cover!) is highly informative and comprehensive. It is detailed but easy to read. The authors provide wide ranging examples of environmental case studies and demonstrate their broad knowledge of the field. I especially liked the emphasis on problem solving. I highly recommend this book as the primary textbook for groundwater geochemistry classes and as at least a supplemental text for general environmental geochemistry courses.

Sabine Goldberg
USDA-ARS
George E. Brown Jr., Salinity Laboratory
Riverside, CA 92507
(sgoldberg@ussl.ars.usda.gov)