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complexities of geochemical kinetics if they are to predict how natural materials will react under a given set of conditions, and infer from preserved attributes of natural materials how long ago, how fast, and for how long past geochemical processes occurred.

Geochemical Kinetics by Youxue Zhang is intended as a graduate- and advanced-undergraduate-level textbook, but it will likely be used for other applications as well. No advanced book on geochemical kinetics yet produced, including this one, has been comprehensive. Nevertheless, the author covers an impressive range of subjects. The book's thorough coverage of rate processes in igneous and metamorphic petrology, volcanology, geochronology, and thermochronology will be especially appreciated by readers with strong backgrounds in geology, chemistry, physics, and mathematics.

A strength of the book is its thorough integration of rate equations from radioactive decay and radiogenic isotope geochemistry with those of geochemical reaction kinetics. Since both geochemical kinetics and radioisotope geochronology are about ages, durations, and rates in natural systems, such an integrated approach is highly appropriate and will hopefully be welcomed by readers. Another positive feature is the book's thorough treatment of inverse methods of applying chemical kinetic concepts to infer the ages, rates, and durations of geological phenomena.

The author is forthright and explicit on what will be covered in detail and what will not. For instance, Zhang barely mentions important concepts, such as transition state theory, and broad topics—aqueous low-temperature geochemistry, for example—that are emphasized in earlier geochemical kinetics textbooks and treatises. So that readers can pursue connections for themselves, Zhang, to his credit, directs readers to a number of major texts of similar rigor; among them are Robert Berner's *Early Diagenesis: A Theoretical Approach* (Princeton U. Press, 1980) and Bernard Boudreau's *Diagenetic Models and Their Implementation: Modelling Transport and Reactions in Aquatic Sediments* (Springer, 1997). The citations to books that address low-temperature systems are particularly helpful because, as the author points out, kinetics considerations are most important for such systems.

The book is easy to read, which is especially praiseworthy given its exten-

sive and detailed mathematical treatments. Few typographical errors appear in the text and the equations, and only minor grammatical idiosyncrasies escaped the otherwise thorough and effective editing and proofing. For some topics, literature citations are comprehensive and self-contained; in other areas, the text relies on a few well-chosen classic treatises. However, at times, ease of reading comes at the cost of limited referencing, and some useful statements—related to cation diffusivity, the Ostwald Step Rule, and radiocarbon dating, for example—are unsupported by citations.

As a textbook, *Geochemical Kinetics* is integrative, computationally rigorous, and pedagogically masterful. It is also practical, with many detailed calculations and worked-out examples. Chapters and sections can stand alone, so readers can use them as foundations for investigating specific concepts and applications without having to jump back and forth within the book. The author warns readers that the approach can make for repetitive reading, but in my opinion,

Zhang's arrangement adds to the value of the book; it is a resource that students can easily navigate even after they have left a course that used it. The standalone units also make the book useful outside the classroom as a reference manual of quantitative approaches and solutions.

Several special strengths have resulted from the text's origin as classroom lecture notes. First, the student-friendly text includes explicit reminders to keep in mind the "little things" that are second nature to experienced geochemical kineticists but common stumbling blocks to novices. Second, the text does an uncommonly good job of being realistic about what it takes to apply the more advanced, complex approaches—what can be done, what cannot be done, what is required, and what is practical. For example, there are sections that present equations for the relationship between diffusivity and viscosity and equations for dealing with diffusion in complex multicomponent systems. Those sections not only clearly characterize the equations and solution methods for which the corresponding theory is well developed but also evaluate each equation and method in terms of how conveniently and rigorously it can be applied to real situations. Finally, the book clearly identifies some large and fundamental gaps in current understanding that deserve future research

effort. For example, many nucleation theories exist, but few have quantitative predictive value; what they lack is clearly highlighted in Zhang's text. All in all, *Geochemical Kinetics* is an excellent book, at home both in the classroom and on the practitioner's shelf.

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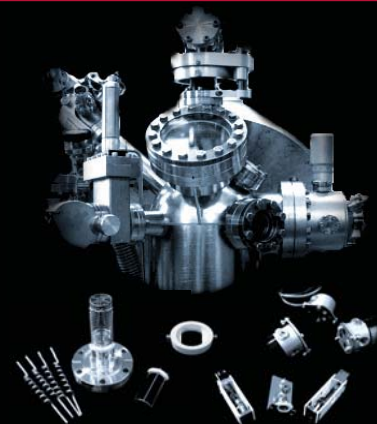
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