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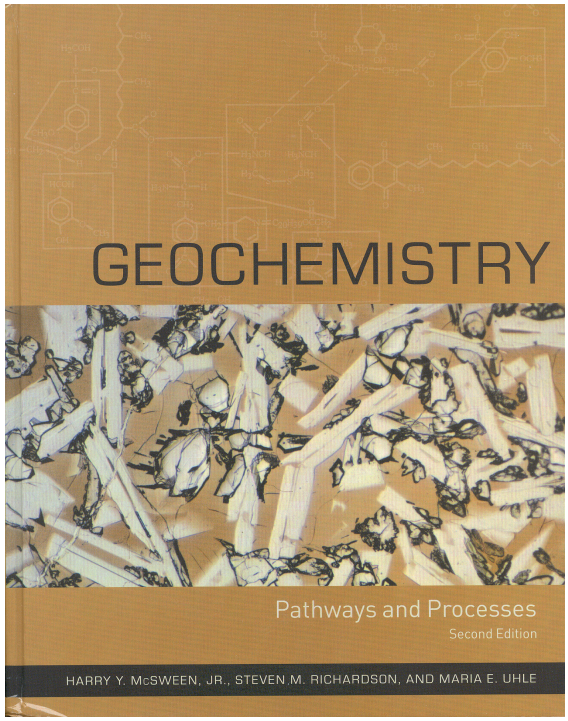
Book Review

Geochemistry: pathways and processes, 2nd ed., by Harry Y. McSween, Steven M. Richardson, and Maria E. Uhle. Columbia University Press, 2003, 520 pp., $89, hardcover. (ISBN 0-231-12440-6)



In the preface to their textbook *Geochemistry: pathways and processes,* the authors state quite correctly that geochemistry now pervades all aspects of geology and that without a working knowledge of geochemistry a modern geologist (or planetary scientist for that matter) will be severely limited. This textbook does an excellent job of providing students with that strong geochemical background. It is firmly grounded in chemistry and written from a pragmatic geological perspective. As a result, the text provides a solid foundation in the fundamentals of geochemistry such as thermodynamics and kinetics, yet makes these concepts relevant by illustrating them with real geologic examples. This book would make an excellent text for a junior-senior level undergraduate geochemistry course.

This book has an effective organization that consists of three parts (although the authors did not divide the text in this manner). The first third of the text introduces fundamental concepts of geochemistry. These concepts are presented in general introductory chapters on geochemical systems, the behavior of elements (structure, classifications, characteristics, etc.), and an introduction to the fundamentals of thermodynamics. These are followed by a chapter on solution chemistry, where thermodynamic principles are illustrated in terms of ideal and non-ideal solutions, and a chapter in which the authors illustrate kinetics by applying it to the process of diagenesis.

In the second part of the text, the authors build on the fundamentals presented in the early chapters and, then, use this foundation to present new concepts. These include chapters on: organic geochemistry, chemical weathering, oceans and atmospheres as geochemical systems, and a second look at thermodynamics and kinetics—this time in more detail by examining non-equilibrium conditions (e.g., changing temperature and pressure) such as those that occur during many geological processes. In each of these chapters, new details are added incrementally to the student's understanding of the "nuts and bolts" of geochemistry.

The final third of this text examines more applied topics in geochemistry using the concepts developed in the first two-thirds of the text. These topics are included in chapters on the geochemistry of the solid Earth, stable and radiogenic isotopes, and cosmochemistry. The chapter discussing the solid Earth as a geochemical system examines the reservoirs of the Earth in terms of its characteristics, the processes that occur within these reservoirs, and the interactions between them. The chapter on stable isotopes introduces the theory of stable isotope fractionation and discusses how natural stable isotope variations are used in geology, with particular application to surficial processes. The chapter on radiogenic isotopes introduces the principles of radioactivity and discusses both the application of radiogenic isotopes to geochronology and their use as tracers of geochemical processes. The final chapter of the text introduces cosmochemistry. It discusses nucleosynthesis, the use of chondrites as sources of geochemical information, cosmochemical behavior of the elements, condensation of the elements, and models for planetary and solar system formation from a geochemical perspective.

There are two particularly strong aspects of this text that are worth highlighting. The first is how this text treats thermodynamics and kinetics. The problem of how to present

thermodynamics and kinetics is perhaps the most difficult task in a geochemistry textbook. If presented too theoretically and with too much depth and detail, many students (particularly undergraduates) quickly lose interest. If presented superficially without any quantitative basis, usefulness is limited because the text cannot be effectively applied to geochemical problems. With this text, the authors strike an excellent balance by being detailed and comprehensive enough to be useful but not so much so that it becomes too "thick" for students to wade through. In addition, the authors present thermodynamics and kinetics incrementally. They introduce the basics of thermodynamics early in the text and follow up with the chapters (titled Diagenesis, Organic geochemistry, Chemical weathering, and Oceans and atmospheres as geochemical systems) in which thermodynamic principles are integrated into different aspects of geochemistry. Then, the authors revisit thermodynamics to discuss in detail such concepts as the phase rule, heat capacity, and the Clapeyron equation within the context of geological examples. These are further reinforced as they are applied to phase diagrams in the following chapter.

The second strong aspect of this text is the authors' use of what they term "worked problems." These are problems chosen by the authors to illustrate different concepts of geochemistry that have been worked out step by step in the text. This is not unusual in a textbook, of course, but the number of detailed problems (88) is impressive. In addition, all these are "real world" problems with obvious application to various aspects of geochemistry. Geochemistry is a quantitative discipline and the ability to work through various applied problems is an essential skill that students need to have after taking any class in geochemistry.

One possible weakness of this text (perhaps reflecting my prejudices and interests) is that it is comparatively thin on stable and radiogenic isotopes and their application to the understanding of the solid Earth and Earth surface processes. In addition, the text does not draw heavily from recent geochemical research. Fortunately, this is something that the instructor can easily remedy by augmenting the text with readings from the current literature.

In summary, this is an excellent, well-written text for advanced undergraduate or beginning graduate students. The writing is not heavy-handed or overly filled with jargon (as is easy to do in a text of this nature), but explains concepts in a way that is easy to understand. It has a logical organization, thoroughly introduces geochemical fundamentals, and illustrates them well with many relevant geological examples. As such, *Geochemistry: pathways and processes* will provide the student with a solid foundation in the broad and expanding field of geochemistry.

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