

## BOOK REVIEW

EARTH MATERIALS by Kevin Hefferan and John O'Brien (2010). Wiley-Blackwell, ISBN 978-1-4051-4433-9 (hardcover), 608 p.

In recent years an increasing number of geoscience departments have elected to combine their introductory mineralogy and petrology courses into a single, one-term “earth materials” course. As a result there has been a need for a textbook that integrates both topics, and this is the niche that Hefferan and O'Brien seek to fill with *Earth Materials*. Their book provides a clearly written and well-illustrated overview of mineralogy and petrology that is suitable for an undergraduate audience.

*Earth Materials* begins with three chapters on crystal chemistry and crystallography that cover all of the basics, giving greater emphasis to macroscopic features (e.g., crystal forms, naming of faces) than to atomic scale features (e.g., space groups). The crystal chemistry discussion covers binary but not ternary phase diagrams, includes a section on isotopes, mainly radiogenic systems, but does not cover analytical methods such as X-ray diffraction. After the crystallography section are two chapters that focus on mineralogy; the first contains a thorough survey of physical properties followed by descriptions of the major groups of rock-forming minerals. Silicate minerals are covered in the greatest detail; whereas, non-silicate mineral groups receive just one or two paragraphs each. The emphasis of the mineralogy discussion is on crystal structures and substitutions; there is only minimal mention of the physical properties, associations, and occurrences of individual minerals. The brevity of this descriptive mineralogy section and absence of any mineral identification tables distinguish *Earth Materials* from a traditional mineralogy textbook. The optical mineralogy chapter provides a thorough overview of how a polarizing microscope works and how and why useful optical phenomena (e.g., interference figures) are observed. It is clearly illustrated with helpful diagrams and a modest number of photomicrographs, but information about the optical properties of individual minerals is limited to a single table of 15 minerals.

The petrologic portion of *Earth Materials* contains 12 chapters that are equally divided among the three major rock types. As in the mineralogy chapters, the authors give greater emphasis to describing and interpreting hand sample features and field occurrences than to microscopic or geochemical characteristics. The igneous section begins with a discussion of textures and classification, well illustrated and integrated with a clear discussion of how various textures develop. Coverage of igneous geochemistry is more limited but includes the necessary fundamentals (e.g., major vs. trace elements, compatible vs. incompatible behavior). The next two chapters

include one on igneous processes, which incorporates some chemical data but no phase diagrams (thus missing an opportunity to illustrate how phase equilibria are utilized), and one on volcanic structures and landforms. The final chapter of the igneous section, an overview of the traits of rocks from different tectonic settings, is comprehensive and utilizes concepts from the earlier chapters, although in places (e.g., traits of boninites) the discussion moves beyond what most introductory petrology students will fully comprehend without additional lecture or reading material.

Coverage of sedimentary rocks and processes begins with an excellent overview of sediment transport and deposition that links these physical processes to the formation of various primary sedimentary structures. This linkage of process and product, accompanied by numerous illustrations of sedimentary structures, helps students interpret rather than just describe clastic sedimentary rocks. Weathering processes, diagenetic changes, clay mineralogy, and soil formation and classification are also clearly discussed in the sedimentary chapters, along with classification systems for both clastic and chemical sedimentary rocks. The weakest aspect of this section is the coverage of depositional environments, which are summarized only in a figure. Providing a little more depth on this topic would enable students to more fully interpret the sedimentary features these chapters so clearly describe.

The metamorphic section of *Earth Materials* covers all of the standard introductory topics including agents and settings of metamorphism and the naming and classification of metamorphic rocks. Rock deformation and metamorphic structures are the topic of a separate chapter, which provides more depth than most other introductory petrology textbooks. By comparison, coverage of metamorphic grade is not as thorough. The authors summarize in paragraph and table form the mineral assemblages for the major facies and protoliths, but the brief discussion of ternary chemographic diagrams is not enough to allow students to actually utilize them. There is no mention, for example, of how to plot a rock composition, how to infer a metamorphic reaction from changes in tie line geometry, or of the difference between continuous vs. discontinuous reactions. Other approaches to determining metamorphic grade, such as mineral thermobarometry, are not discussed, and thermodynamics in general is not mentioned.

A final stand-alone chapter on mineral resources provides a concise overview of both ore deposits and industrial minerals, accompanied by a table of the occurrences and uses of some less common but economically important elements. The health effects of various elements and minerals are also mentioned.

Overall, *Earth Materials* is a clearly written text well suited for an introductory-level undergraduate course in mineralogy

and petrology. Because the authors elected not to include systematic descriptions of minerals or determinative tables of mineral properties, the book will in most cases not suffice as a stand-alone course text, or as a “rocks and minerals” reference book. However, there are numerous inexpensive mineral guides that can be used to supplement this book and meet that need. *Earth Materials* would also be strengthened by the addition of end-of-chapter problems/questions, and by having a more comprehensive companion website. At present, the latter

includes only illustrations from the book, which are of limited use to students. Hopefully, future editions of the book will incorporate some of these elements, strengthening an already solid and much needed text.

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