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BOOK REVIEWS

IGNEOUS PETROLOGY. By Alexander R. McBirney. Illustrated by Christine McBirney. Freeman, Cooper & Company, San Francisco, California, U.S.A., 1984. 510 pages. $38.75.

Over about the last fifteen years the study of igneous rocks has branched out considerably from a descriptive science based on petrographic observation and experiment to a quantitative science that requires igneous petrologists to have a basic understanding of such diverse fields as thermodynamics, fluid mechanics, and isotope and trace-element geochemistry. In addition, petrologists now realize that the processes responsible for the chemical evolution of magmas are complex and often involve combinations of many simpler processes. A modern igneous petrology text must be able to introduce the student to the varied subfields of the science and show how they contribute to unraveling the complex interactions that drive the evolution of magmas. To write such a book is a formidable task, and any author who attempts such an undertaking is to be commended.

Dr. Alexander R. McBirney has attempted to write such a book and to a large degree has succeeded. His book *Igneous Petrology* is directed toward students with an "elementary background in petrography and petrology." In Chapter 1, "The Earth and Its Magmatism," the origin and differentiation of the Earth is discussed and compared to other bodies in the Solar System. This is followed by a general overview of magmatic sources and the relationships between magmatism and tectonics. Chapter 2, "Magmas and Igneous Rocks," discusses the composition of igneous rocks and the interrelationships of elemental variation. It presents a clear-cut classification scheme for both plutonic (IUGS classification) and volcanic (chemical classification of Irvine and Baragar) rocks, which, if followed by everyone, would make classification much simpler. Chapter 2 then presents a lucid discussion of volatile solubilities, physical properties, and structure of silicate liquids, along with an easy-to-understand synopsis of mass and energy transfer as it relates to ascent of and convection in magmatic bodies. In Chapter 3, "Crystal-Liquid Relations," the reader is first introduced to thermodynamics. Here, the discussion requires the reader to have a basic knowledge of thermodynamics and suffers from a lack of consistency in notation. For example, equations are first presented in terms of the Gibbs free energy and then in terms of chemical potential, without any explanation as to how the two quantities are related. The reader is next introduced to phase diagrams, first from the thermodynamic approach relating phase stability to minimum Gibbs free energy and then from the standard approach of geometrical phase-diagram interpretation. Here the book fails to make its point because of inconsistencies between text and figures. For example, on page 89, in the discussion of the lever rule, the figure is labeled incorrectly, resulting in liquid and solid fractions opposite to those given in the text. Figure 3–7b is completely missing, although the caption is printed, and Figures 3–20b, 3–22, and 3–23 do not contain some of the information discussed in the text. Because phase-diagram interpretation is generally difficult and confusing to the beginning student, these inconsistencies make it impossible for the student, with no prior knowledge of phase diagrams, to learn from this chapter. "Igneous Rocks and Their Textures" is the title of Chapter 4, which discusses the common igneous minerals and factors that control their stability. Kinetic factors relating crystallization and growth of minerals are discussed, and igneous rock textures are explained and illustrated well. Chapter 5, "Magmatic Differentiation, Mechanisms and Effects," is up-to-date with current research and includes discussion of crystal-liquid fractionation, fractional melting, liquid-liquid fractionation (including boundary-layer effects, immiscibility, and the Soret effect), assimilation, magma mixing, liquid-vapor fractionation, and combinations of these mechanisms. Trace-element geochemistry is also introduced and clearly presented. The limitations of the various tests by which mechanisms can be deduced are also considered. Chapter 6 is entitled "Magmatic Differentiation—Basic Intrusions." Herein, the mechanisms of magmatic differentiation are first presented and are followed by examples from several well-studied basic layered intrusions. Overall this is a good chapter and shows the student how rocks should be studied. In Chapter 7, "Basalts and Magma Series," the concept of magma series is discussed in relation to the two common oceanic magma series, the MORB series and the alkaline series. Illustrative examples of each include discussions of phase equilibria and petrography. Several things detract from this chapter: The concept of silica activity is introduced without any previous discussion of its meaning, inconsistencies between text and figures are noticeable, and important differences between tholeiitic rocks from oceanic ridges and those from oceanic islands are not treated. Chapter 8 is entitled "The Origins of Basaltic Magmas" and considers the concept of primary magmas, melting mechanisms, and mobilization and transport of magma from the mantle to the surface. These concepts are very well explained; however, the discussion suffers from the fact that the origin of magma is considered from the point of view that the mantle has a single composition. It would have been an excellent time to discuss isotopic variations relating to mantle composition at this juncture, but, isotope geochemistry is left to Chapter 9 and the Appendix. "Orogenic Volcanic Rocks" is the subject of Chapter 9. The approach here is to discuss the tectonic setting, give a general overview of the suite of rocks, including petrographic features, and present a few well-studied examples. The origin of the calc-alkaline suite is then considered from experimental studies, with isotope geochemistry introduced to examine the possible role of crustal assimilation and subducted sediments in the production of the suite. The discussion here leaves the reader with the notion that the origin of the calc-alkaline suite is not well understood, as indeed, it is not. Chapter 10, "Granitic Plutons and Siliceous Ignimbrites," discusses petrography and geologic occurrence of siliceous rocks, covers phase relationships in simple systems, has an extensive treatment of the effects of water on the crystallization of granitic magmas, including element partitioning between liquids and vapors, and integrates studies of trace elements and radiogenic and stable isotopes as they pertain to the studies of the origin and evolution of granitic magmas. Finally, "Alkaline Rocks of the Continental Interiors" is the subject of Chapter 11. This chapter contains a brief overview of a wide variety of rock types including the more common sodic and potassic series, as well as carbonatites, lamprophyres, and kimberlites. Selected examples of the occurrences of these rocks are discussed along with petrography and phase relations in pertinent simple and complex systems. This is followed by an overview of the various theories held to explain these diverse rocks and a

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summary that attempts to tie the origins of these rarer rock types to the more common igneous rocks and a model of the Earth.

The book is written in an expository style and does not cite references to published works to which the reader can refer for more details. Thus, there is no extensive bibliography, but instead a list of selected references (mostly books) for each chapter. The appendix covers additional material relating to calculations of CIPW and cation norms, and densities and viscosities of silicate melts, as well as a discussion of radiogenic isotope systematics (including a major error in Figure D-3c, incorrectly showing the crust with a higher $^{143}Nd/^{144}Nd$ than the upper mantle). It also contains a set of interesting problems to be worked by the student for each chapter and a useful glossary of igneous rock names and terms. Unfortunately, the appendix was not typeset, but reproduced from typewritten copy containing several typographical errors that detract from the appearance.

Overall, the book is well written in a nondogmatic style and gives a well-balanced treatment of the study of igneous rocks. Its major weaknesses are its lack of consistency between text and figures, its poor treatment of thermodynamic concepts, its failure to integrate isotope geochemistry into the discussion of the origins of the various basalt types (although this is done to some extent in the appendix), and its lack of an extensive bibliography. If supplemented by other materials to make up for these deficiencies, it could be an excellent text to introduce the student to the complexities of the study of igneous rocks.

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A PRACTICAL GUIDE TO FLUID INCLUSION STUDIES. By T. Shepherd, A. H. Rankin, and P. H. M. Alderton. Blackie, 1985. 239 pages. $59.95.

This is the third book in recent years on the study of fluid inclusions; it is the first in hard cover and is substantially more expensive than the other two. It is arranged in ten chapters: (1) occurrence of fluid inclusions, (2) sample selection and preparation, (3) optical examination, (4) principles, (5) heating-freezing stages, (6) practical aspects of using heating-freezing stages, (7) interpretation of data, (8) and (9) chemical analyses of fluid inclusions, and (10) future trends.

Errors and omissions are numerous. Examples include the absence of CO from the list of components detected in fluid inclusions, the absence of olivine from the list of minerals that commonly contain fluid inclusions, an enthusiastic reference to a paper on fluid inclusions in meteorites which have since been shown to be artifacts, and naming the USGS stage by the name of one of several suppliers.

The experience of the authors appears to be primarily with aqueous inclusions in hydrothermal deposits. Students of CO_2-rich fluid inclusions in metamorphic and igneous rocks might take exception with the statement (p. 39), "By far the most common phases in fluid inclusions are an aqueous solution and a mobile vapour bubble." The virtual absence of discussion of how one can optically deduce the probable existence of a condensed gas within small vapor bubbles confirms the bias of the book toward aqueous inclusions.

Is it worth the price? I think not, because most students will demand more content after quickly grasping the material presented in the book. Most sections are quite elementary, and the lack of references to many of the concepts and figures will be a frustration to those who want to know more. Many people who have done research on fluid inclusions will be upset by finding figures from their papers reproduced without any acknowledgment of source of figure, not to mention the lack of reference to sources of data used to construct the figures.

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