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BOOK REVIEWS

ORIGINS OF IGNEOUS ROCKS. By Paul C. Hess. Harvard University Press, Cambridge, Massachusetts, 1989. 336 p. $65.00 hardback.

Books on igneous petrogenesis have been rare in the last two decades (it's been 15 years since Carmichael, Turner, and Verhoogen!) and so it was with great anticipation that I awaited receipt of this book. On reading it from cover to cover, I have not been disappointed, but I have been surprised.

The first question a reviewer has is: What is the purpose of this book and at whom is it aimed? In the Introduction, Hess states definitely that this is a book about igneous petrogenesis rather than petrography or field petrology. But is it intended for an undergraduate petrology class, a graduate level advanced petrology class, a graduate seminar in igneous petrogenesis, or a professional reference book? The author keeps us in the dark on this one, but my vote is for a graduate course in advanced igneous petrology or igneous petrogenesis.

The book is divided into two sections; the first provides background information by covering principles of phase equilibria, magmatic processes, trace and isotope geochemistry, properties and structure of silicate melts, the petrology and geochemistry of the Earth's mantle, and the definition of primary magmas and how to identify them. This section is covered in about one-third of the book. The remainder of the book is divided into chapters that cover igneous rocks found in specific tectonic settings or specific rock types. These range from broad groups like "Intraplate Volcanism" to restricted rock types such as "Anorthosites." There is a strong emphasis on mantle-derived rocks and a final chapter on "Lunar Petrology."

In the introduction, Hess states that "Modern igneous petrology and trace/isotope geochemistry can no longer be separate disciplines but must be closely integrated." He does an exceptionally good job of doing just that in every one of the chapters in the second half of the book. In those chapters he begins with a very good, detailed presentation of the known petrologic, geochemical, and geologic data available on a given rock type. He then presents multiple working hypotheses for the origin, and often finishes with a choice of preferred hypotheses. The approach used in these chapters is excellent, and Hess manages to convey a real enthusiasm for the surprises and enigmas found in the study of igneous rocks.

The reason I was surprised by this book is that Paul Hess is one of the pioneers in unraveling the structure and thermodynamics of silicate melts, and so I thought his book would emphasize the theoretical aspects of magmas and give short shrift to descriptive petrography and geochemistry. If anything, the opposite is true! The chapter on "The Nature of Silicate Melts" is brief and does not discuss any of the current models for calculating thermodynamic properties of melts, and hence, phase equilibria (for instance, the Carmichael and Burnham-Nekvasil schools). There is a general lack of interest in intensive variables throughout the book, and little attention is paid to the details of how the H_2O content of a melt can be estimated or calculated and how the H_2O content changes details of crystallization and physical properties of magmas. Perhaps the reason for this omission is that "granitic" petrogenesis is barely covered. For instance, S-type granites are lumped under "Anorogenic Granites and Rhyolites." The other noticeable omission is in the reference list; neither Wayne Burnham nor Mike O'Hara are referenced although their fundamental contributions form the basis of many of the hypotheses discussed.

Those omissions are not an overriding reason for shunning this book. This would be a really excellent book for a graduate-level class on igneous petrogenesis. It would also be a useful reference book for anyone wanting a good summary of most of the current thinking on many of the rock types covered; however, the book does not provide an exhaustive current literature survey. The hardback book is well designed and large and even at $65 is a good value.

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CLASSICAL MARBLE: GEOCHEMISTRY, TECHNOLOGY, TRADE. Edited by Norman Herz and Marc Waelkens. Kluwer Academic Publishers, Dordrecht/Boston/London, 1988. 482 pages. $124.00.

This book is a compilation of 49 papers that were presented at a NATO Advanced Research Workshop held at Il Ciocco, Italy, May 9–13, 1988. Here an international and interdisciplinary group of geologists, geochemists, archaeologists, architects, and art historians were assembled to discuss the provenance, quarrying, transport, and use of marble by the ancient Mediterranean civilizations. I find that this series of papers presents a fascinating merger of two cultures—the culture of the technologist represented by the geoscientists and the culture of the classicist represented by the historians, architects, and archaeologists. We have geoscientists quoting ancient history when describing the geology of marble deposits and classicists alluding to carbon and oxygen isotopes and trace-element distribution when discussing the possible sources of Roman and Greek statuary.

The chapters in this book are divided into ten sections: (1) introductory material, (2) quarries and quarrying technology, (3) marble dressing, (4) trade and archaeological use of marble, (5–8) determination of marble provenance

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by petrological and chemical analysis, trace-element analysis, stable-isotope analysis, xeroradiography, ESR spectroscopy, X-ray powder diffractometry, and pore-size distribution, (9) provenance determination applied to ancient artifacts, and (10) decay and conservation. Co-editor Norman Herz, a geologist from the University of Georgia, U.S.A., and one of the pioneers in applying geologic concepts to archaeological problems, begins the volume with a geological survey of the marble resource regions of Greece and Turkey. Marc Waelkens, the other co-editor and an archaeologist from the Catholic University of Leuven, Belgium, continues with a very interesting discussion of the quarries and marble trade in antiquity; this chapter is an introduction to the following series of papers, which give details on marble extraction techniques, identification of tool marks, methods of marble transport, quarrying technologies, and descriptions of several ancient quarries located in Greece, Italy, Turkey, Egypt, and Sardinia. The next fifteen chapters, which present specific geochemical and petrologic techniques for determining the possible sources of the classical marble (the provenance), are of the most interest to the geoscientist. As a result of the seminal work of Harmon and Valerie Craig in 1972, the use of stable-isotope ratios of carbon and oxygen became very important in determining the provenance of the ancient marbles. There are five papers on this subject. In addition, three papers on provenance studies utilizing trace-element analysis and seven more involving other analytical methods are presented. For example, the use of isotope and trace-element techniques show that marbles from quarries on the adjacent Greek isles of Naxos and Paros have distinctly different isotope and trace-element characteristics. Thus, by using the various analytical methods described in this volume and the historical record, the source localities of such important artifacts as the Antonia Minor portrait (Fogg Museum, Harvard University) and Livia portrait (Ny Carsberg Glyptotek Museum, Copenhagen) were determined.

I found the reading of this series of papers on classical marble to be a most rewarding experience. For those who wish to combine a journey into classical scholarship with geological science I highly recommend this work.

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