has the clarity essential in a laboratory manual and the possible pitfalls and possible misconceptions are exposed at each stage. It is well produced and well illustrated throughout. The sections on optical and thermometric analysis contains photographs of the full range of fluid inclusions likely to be encountered and the changes that occur during heating and freezing. The use of relevant diagrams (P-T, phase, etc.) to explain the observed changes during thermometric analysis prove very useful in the understanding of the data acquired.

There is some theoretical discussions of the data but this is used to provide an understanding of the data *senso stricto* rather than provide petrogenetic interpretations.

This book admirably achieves its aim of providing a usable laboratory manual for those involved in the study of fluid inclusions. It is highly recommended by the reviewer, especially to those entering this field. Users of the book will benefit greatly from the authors' practical experience and improve their chances of producing well qualified data efficiently.

R. A. D. PATTRICK

Berry, F., and Vaughan, D. J., *Chemical Bonding and Spectroscopy in Mineral Chemistry*. London and New York (Chapman and Hall), 1985. x + 325 pp., 129 figs. Price £35.

The editors of this book on spectroscopy and bonding present a welcome and most timely contribution to the mineralogical literature. In recent years there has been a rapid increase in the number of spectroscopic techniques used in the study of minerals, but because of the lack of suitable texts it has often proved difficult for the non-specialist to learn and appreciate the significance of the results obtained by these investigations. This book goes a long way towards solving the problems faced by non-spectroscopists in their attempt to incorporate the findings of spectroscopy into their larger understanding of mineral behaviour.

Almost inevitably a book attempting to cover the wide range that spectroscopy now encompasses must be a multi-author affair, and indeed this is both the strength and the weakness of this volume. The strength naturally derives from the expert knowledge that each author can bring to his chapter, while the weakness, although not strongly pronounced, must derive from the differences in styles, approach and thoroughness of each chapter. The uniting theme in all of the chapters, however, is how various spectroscopic observations shed light upon the nature of bonding in minerals. To this end, the introductory chapter by J. A. Tossell on the applications of quantum mechanics to bonding in minerals is both lucid and an essential part of the volume.

The three subsequent chapters by D. S. Urch, R. G. Burns and G. Walker deal with various aspects of the interaction of electromagnetic radiation with electrons in minerals. Although the three techniques discussed, X-ray spectroscopy, electronic spectra and luminescence techniques all provide insights into the distribution of electrons in minerals and their relative energetics, I feel that a chapter on infra-red and Raman spectroscopy would have strengthened this part of the text. Nevertheless, these three chapters all provide an excellent guide and introduction to the spectroscopic techniques to which they are dedicated.

The next two chapters are concerned with the interaction of radiation with atomic nucleii. A. G. Maddocks' chapter on Mössbauer spectroscopy is a fine review of a more familiar but underused mineralogical technique, while W. R. McWhinnie's chapter on resonance spectroscopy outlines the theory of an approach to mineralogical study which I am convinced is going to grow in importance in the next decade. Finally the editors each contribute more specialist, but equally informative, chapters on the nature of bonding in opaque minerals and on mineral surfaces. The study of opaque minerals is neglected in the main by mineralogists and petrologists, but as D. J. Vaughan's chapter reveals, much can be gained from investigation of these phases. F. J. Berry's chapter on surfaces addresses the least well known aspect of mineral behaviour, but one which is potentially the most important and challenging area of mineral physics. Despite our relatively extensive knowledge of the behaviour of single-crystal minerals, we are as yet unable to use that knowledge to predict the nature and properties of polycrystalline aggregates such as rock. Until we understand mineral surfaces and grain boundaries, we will be unable to apply our knowledge of the physics of minerals to describe the physics of the Earth, and as such the chapter by Berry may point the way to much future mineralogical research. This whole text is most worthwhile and thoroughly recommended.

G. D. PRICE

Maaløe, S. *Principles of Igneous Petrology*. Berlin, Heidelberg, New York and Tokyo (Springer Verlag), 1985, xiv + 374 pp., 291 figs. Price DM 138.00.

Petrology is both descriptive and interpretative. In the interpretative part the various observations made are synthesized into a plausible physical and chemical scheme of petrogenesis. Extending the

limits of petrogenetic theory and making it more quantitative requires an ever more thorough grounding in and intimacy with physics and chemistry, and that, in essence, is the aim of this new text. To quote from the Preface, 'the application of physical and chemical principles, by using equations and various constraints, is mandatory for the understanding of the generation of magmas'; and 'to convert an idea into equations is frequently a difficult task, and represents a real challenge for the present generation of the students of igneous petrology'. In short, Maaløe offers a more mathematically based analysis of petrogenesis than is customary in textbooks.

Monary, binary, ternary, and pseudobinary systems are the subjects of the first four chapters, followed by ones on P–T diagrams, Schreinemakers' phase theory, gas-bearing systems, and oxygen fugacity. Chapters on partial melting, and on fractional crystallization follow and are succeeded by the final three on magma kinetics, magma dynamics and isotope geology. In all chapters there is at least one item likely to challenge even the most experienced petrologist, and plenty of new slants on already well-worked topics. I found the chapters on partial melting, fractional crystallization, magma kinetics, and magma dynamics especially welcome, although the sections on redistribution of solute during crystal growth are too brief. Conspicuous by its absence is a treatment of the application of chemical thermodynamics to the problems of igneous petrogenesis, maybe it was felt too large a subject to tackle.

Considering that English is not the author's native tongue, the text is easy to read, and for the most part well written, generally lacking the turgid, repetitive style that can arise in these circumstances. There are some irritating proof-reading failures that accompany any first edition, such as incorrect references to figures, wrong symbols in equations, and a few places where the meaning is unclear. The index is inadequate—in fact a bare minimum. In the main, however, the presentation is of high standard.

While no other text covers precisely the same subject matter, there is considerable overlap with the books by Carmichael, Turner, and Verhoogen, by Morse, by Yoder, and by Cox, Bell, and Pankhurst. What distinguishes this book is the rigour of the treatment of physical and chemical principles. As a consequence, beyond some selected pages, I would not recommend the book to any but the most capable of undergraduates, for graduate students and advanced researchers a copy should be compulsory reading.

Will Maaløe's hopes for a more numerate next generation of igneous petrologists come about? Yes they will, this change is already happening. The service which Maaløe and other authors do for their science is to assist and stimulate this generation of petrologists to acquire the theoretical skills and knowledge necessary to improve the training of research students, and necessary to propel igneous petrology into the next century.

C. H. DONALDSON

Gottardi, G., and Galli, E. *Natural Zeolites.* (Minerals and Rocks: Vol. 18). Berlin, Heidelberg, and New York (Springer-Verlag), 1985. xii + 409 pp., 218 figs. Price DM 160.00.

After a brief introduction, including a listing of the thirty-two zeolite species, the topology of the tetrahedral frameworks of natural zeolites is described. There then follow chapters giving much-needed up-to-date details of each of the zeolites, including their crystallography, major and trace-element chemistry, optical and physical properties, thermal and other physicochemical properties, occurrences and genesis, uses and applications.

The wide use of scanning electron micrographs to illustrate this monograph is to be commended; the SEM photographs of mazzite and erionite are impressive and some of the cathedral-like images of harmotome are unforgettable. The individual species are grouped under seven headings according to their morphology and structure, and each species is described in detail with selected chemical analysis and optical and physical properties where available. The indexed X-ray powder patterns of all the species and infra-red spectra of the fibrous zeolites are given in appendices. Most of the thermal curves and many of the X-ray patterns have been specially recorded and interpreted by the authors, in order to guarantee homogeneity of all the data. For rare species the information in the text and tables represents nearly all that is currently available, whereas for more common minerals a representative distillation of data has been presented. One criticism would be that the sections on occurrence and genesis, although fully covering the geographical distribution of the individual zeolites and the broad nature of their enclosing rocks, offer little information on any zonation among the zeolite species or the occurrence of a particular zeolite in individual lava flows.

Some one thousand references are collected together at the end of the volume and there are separate mineral and locality indexes. The book is attractively laid out with a clear typeface and well-presented diagrams. This work presents a welcome modern approach to the study of zeolites and provides a source of authoritative information