to systems such as the plagioclase feldspars and spinels.

The basic ideas behind thermodynamics, which determine most aspects of mineral behaviour, are clearly presented, with discussions of entropy, phase equilibria and Landau theory. The nature of solid solutions is outlined, the processes of exsolution, spinodal decomposition and ordering are reviewed. Finally kinetics are introduced, and the book ends with some excellently presented case studies of transformation processes, including discussions of the incommensurate behaviour in quartz, unmixing in the pyroxene system, and other geologically and materials-relevant processes.

In short, this book is a tour de force, illustrating clearly the major advances which have taken place in our understanding of the complex behaviour of minerals and related phases. It could only have been written by a scientist who has an extensive and clear understanding of modern mineralogy. Andrew Putnis is to be congratulated on writing an outstanding book, which will not be surpassed for many years to come. Buy, read and enjoy this splendid book!

G. D. PRICE

Gribble, C. D. and Hall, A. J. *Optical Mineralogy: Principles and Practice*. London (UCL Press Ltd.), 1992. Price £50.00 (£17.95 paperback).

This book is a revised and extended successor to *A practical introduction to optical mineralogy* (by the same authors) published by George Allen and Unwin (1985; 249 pp). The latest book retains much the same style, content and organisation as its predecessor, from which it has inherited most of the illustrations. The book aims to provide an introduction to the theory and practice of the examination of rock-forming minerals under the microscope, including both transmitted- and reflected-light techniques, and is comprehensive enough to satisfy the requirements of most undergraduate geology courses.

The separation of the theory of both transmitted- and reflected-light optics (Chapters 4 and 5) from the first chapter on microscope techniques allows a simple 'recipe book'-type approach to mineral study, without encumbering the student with the need to initially wade through theoretical considerations. This arrangement, however, is not in practice entirely user-friendly, since there is a number of references in Chapter 1 to Figures and colour Plates (4 pages) positioned much later in the book.

The descriptions of silicate and non-silicate minerals (Chapters 2 and 3) are presented in broad alphabetical order with related minerals kept together in groups. While the silicate mineral diagrams show optical orientations and give information such as cleavage and 2V, they do not indicate well the characteristic mineral forms, as presented for many of the non-silicates, and only a few selected silicates are illustrated by photomicrographs. The misidentification of a granophyric intergrowth of quartz and feldspar in a photomicrograph as a myrmekitic texture appears to be an isolated error, but could cause some minor confusion. Diagrams giving comparative extinction angles (e.g. for pyroxenes) are very useful.

Transmitted-light theory is dealt with in a straightforward manner, although the explanation of interference in crystals and the origin of interference colours may not be easy for students to assimilate. While crystal symmetry is very briefly dealt with in relation to reflectance of opaque minerals, no outline is given of the distribution of crystallographic axes in the individual crystal systems, which is an omission that students beginning the subject may find a disadvantage. The reflected-light theory provides a useful background to the study of opaque minerals, including reflectance measurement and observation of anisotropy.

Understanding the ways in which light interacts with minerals in the polarising microscope, and becoming competent in microscope techniques are aspects of geology courses that students frequently find very difficult. This textbook offers a sound, traditional approach to *both* transmitted- and reflected-light microscopy, *and* incorporates much useful reference data on the common minerals all in one relatively affordable volume, which is to be commended. It does not, however, seize the opportunity to adopt a markedly fresh approach to the presentation of the subject at student level.

R. KANARIS-SOTIRIOU

McBirney, A. *Igneous Petrology Second Edition*, (Jones and Bartlett Publishers Inc.), 1992. xii + 508 pp. Price $52.50

These are exciting times in Igneous Petrology. The number of new approaches and techniques continues to increase, and there is a welcome trend towards much better integration of contributions from different subject areas. Radiogenic isotope analyses are now only rarely presented in isolation from major and trace element data on the same rocks; laboratory and computer models provide much needed constraints on the physical

processes of magma generation and differentiation, and these are increasingly integrated with the results from phase equilibria and geochemical studies. Information that used to be regarded as the domain of the specialist now needs to be understood by general students of igneous rocks, there is much to be learnt, and the challenge to the writers of text books is immense. The appearance of the second edition of Igneous Petrology by Alexander McBirney just seven years after the publication of the first edition is at least in part a comment on the dramatic rate at which this subject advances.

I approached this book cautiously. There are a number of text books in this field, and a glance at the contents list indicated that in the first chapter I would be introduced to the early evolution of the Earth, the use of radiogenic isotopes in the development of models for the evolution of the crust and mantle, and the nature of the mantle. Chapter 2 introduces the names of common igneous rocks, comments on a number of classification schemes, and then moves adroitly into the physical properties of magmas. The latter have too often been kept separate from discussions of the mineralogy and chemistry of igneous rocks, and it is one of the great strengths of this book that they are introduced, and introduced early. By now my doubts had gone. Aspects of the links between magma composition and physical properties are still controversial, but an understanding of the effects of cooling and crystallisation on density and viscosity and hence on the physical characteristics of magmas provide an excellent spring board from which to consider crystal–liquid relations, in Chapter 3. Some basic thermodynamics leads into the significance of equilibrium in so much of our petrological thinking, to the phase rule and from there to a selection of two, three and even four component systems described on phase diagrams. The pace is fast; eutectics, cotectics, assimilation, solid solution and immiscibility follow in quick succession, but the writing is clear and precise.

Chapter 4 is entitled 'Igneous Minerals and their Textures', and it provides an introduction to igneous minerals, both in the context of phase relations, and with strong links to the information available from the textures of the rocks themselves. However, the key chapter is arguably Chapter 5 on Magmatic Differentiation, for this brings together the chemical and physical aspects of differentiation. The first establishes compositional differences between one or more phases, usually in response to changing physical conditions, and the second preserves these differences by segregating or fractionating the phase so they can form distinctive rocks. As stated in the introduction to Chapter 5 'the trends of magmatic differentiation are determined by crystal–liquid relations, such as those portrayed in phase diagrams, but the degree to which these trends develop is governed by the effectiveness of the physical mechanism of fractionation'. Chapter 5 considers aspects of crystal–liquid separation, of partial melting and zone refining, liquid–liquid fractionation, and assimilation, before looking at the compositional effects of such differentiation processes, and at the role of minor and trace elements in evaluating partial melting and fractional crystallisation processes.

In practice, Chapter 5 is the watershed in that by the end of it the nature of the approach is well established and most of the techniques required in the rest of the book have been introduced. Subsequent chapters consider igneous rocks in different settings, starting with magmatic differentiation processes as inferred from the study of basic intrusions. This provides close links between rock textures, mineralogy, bulk rock compositions and the processes of magma differentiation, and it makes an excellent precursor to a more general chapter on Basalts and Magma Series. This explores the effects of partial melting, the conditions under which it is likely to occur, and the evidence both from mantle peridotites and from experimental petrology. The remaining chapters cover areas such as, Oceanic and Flood Basalts, Orogenic Volcanic Rocks, Granites and Siliceous Ignimbrites, and the Alkaline Rocks of the Continental Interior. Reading lists are confined to half a dozen papers or books at the end of each chapter, but a useful series of Appendicies provide such useful items as a Glossary of Rock Names, a summary of trace element distribution coefficients, and a number of common calculations from molecular norms to mathematical functions of radiogenic isotopes. Finally, there are twenty pages of illustrative problems linked to each chapter.

Overall, this is a most rewarding book. Not much is easy, and the reader is certainly not spoon-fed. A great deal is challenging, and as there is often not space to develop particular points, readers must do that for themselves. However, it makes connections which are too rarely made, and which are therefore the starting point for thought-provoking discussions. I am reminded most of a series of lectures by a distinguished scientist and a first rate teacher. Of course there is a personal slant, and that is one of the delights, but there is also great insight and a breadth of knowledge lucidly brought together in one volume. We should be grateful that Professor

McBirney has taken the trouble to put these particular lectures down on paper for a wider audience.

C. J. HAWKESWORTH

Shelley, D. *Igneous and Metamorphic Rocks Under The Microscope. Classification, Textures, Microstructures and Mineral Preferred Orientations.* London (Chapman and Hall), 1992. xv + 445 pp. Price £24.95.

This book is about those parts of hard-rock petrology that use the optical microscope as the analytical tool. Features visible only with the scanning or transmission electron microscopes are not included, and chemical petrology is not considered. The author intends that students use the book initially as a basic guide to petrography and then as a route into the research literature, once their interest in textures and rock fabrics has been kindled.

Part One deals with rock nomenclature and the mineralogical and textural characteristics of individual rock types. The IUGS scheme is used as a framework for the igneous rocks, and a similar hierarchical scheme is adopted for metamorphic rocks. Part Two opens with a discussion of the principles of crystallisation and recrystallisation and is followed by treatments of the nature and origin of twinning, zoning, intergrowths, and volcanic, plutonic and metamorphic textures. Part Three discusses the mechanisms by which preferred crystal orientations develop in metamorphic rocks, principally, but also in igneous ones. It includes instruction in how to use the Universal Stage in such studies and how to interpret data patterns in stereograms. The book closes with an extensive combined index and glossary.

Coverage of textures and rock types is comprehensive and amply illustrated with carefully chosen, high quality, black-and-white photomicrographs. The layout is attractive and the writing style flows smoothly.

In my opinion Parts One and Two are out of sequence. It is eccentric that each rock type in Part One has a statement about the textures present and yet the vocabulary of textures is dealt with in Part Two, or has to be accessed via the glossary. Students may well get frustrated by this arrangement. (They are also likely to be frustrated by the absence of glossary entries defining the terms *texture, structure,* and *fabric*!)

The 200 pages of Part Two are the meat of the book. The information on textures is comprehensive and commendably up-to-date, for example Bruce Marsh's introduction of crystal size distribution curves is included, as is Bob Hunter's work on cumulate maturation, both of late 1980's vintage. The majority of references are from the last decade which helps to convey that micropetrography is alive and evolving, though it obscures the fact that many features were recognised up to 150 years ago. Students need to be aware of this, so that some, at least, will investigate old descriptions and interpretations. A short section on the history of micropetrography would have helped to make this point. Only 3 pages are allotted in the chapter *Crystals and crystallization* to nucleation, diffusion and crystal growth. Concepts such as interface attachment kinetics, layer spreading versus continuous growth, spiral versus surface nucleation growth, surface free energy, and compositional convection ought to have been included here. Their absence is a missed opportunity to engage students in these important current ideas about crystal growth in geological systems.

Therefore, while my students will find this book in their library, I am in two minds about urging them to purchase a personal copy.

C. H. DONALDSON

Brown, P. E. and Chappell, B. W. (eds.) *The Second Hutton Symposium on the Origin of Granites and Related Rocks.* Edinburgh (Royal Society of Edinburgh), 1992, 507 pp. Price £55.00.

This volume, which also constitutes volume 83 parts 1 and 2 of the *Transactions of the Royal Society of Edinburgh: Earth Sciences*, contains the proceedings of the Hutton symposium held at Canberra in September 1991. It comprises 43 papers (M.A. 93M/3443–3485) and 70 abstracts, with a worldwide authorship representing a fair cross-section of the most active researchers on granites and related rocks. Naturally there is a strong emphasis on geochemical studies, but a few structural papers are also included.

Many of the authors describe particular granite complexes, and interpret their compositional variation in terms of more or less plasuible genetic models. The I- and S-classification continues to be popular, particularly among the Australian authors, and the first paper in the volume is a review by Chappell and White of the I- and S-concept as applied to its type area, the Lachlan fold belt. As well as occasional references to A- and M-type granites, a new alphabetic category, C-type, is introduced by Kilpatrick and Ellis to describe those magmas produced by dry melting at very high temperatures which give rise to igneous charnockites. Lower crystal orthopyroxene-