of multicomponent phase equilibria using the method of free-energy minimization to combine data on fictive Al_2O_3–$MgSiO_3$ with data for $MgSiO_3$–$FeSiO_3$, and a paper by the late Roger Strens, with Mao and Bell, discusses the optical spectra of a meteoritic fassaite and of blue titanian omphacites. Other papers in Part III are concerned with the monoclinic–triclinic inversion as a high-order phase transition in alkali feldspars (Merkel and Blencoe), Gibbs free energies of formation for the aluminium hydroxide phases (Hemingway).

In all, eleven papers are presented of which only those in Part I really hang together; the rest of the volume more represents the variability to be found in normal journals.

R. A. HOWIE

Whittaker, E. J. W. *Crystallography: an Introduction for Earth Science (and Other Solid State) Students.* Oxford and New York (Pergamon Press), 1981. xii + 254 pp., 211 figs. Price (Hardback) £13·50, (paperback) £8·35.

This book corresponds with a one-term course concerned with the external forms of crystals intended for first-year students in Earth Sciences at Oxford, and to a one-term course for second-year students concerned with diffraction and the internal symmetry of crystals.

The text covers the topics important in an introductory course (Part I) (symmetry elements, stereographic projections, Miller indices, zone relationships, morphology of the seven systems and a systematic treatment of the thirty-two classes) with an economy of effort possible only for a very experienced practitioner.

Part II is particularly directed at earth science and other solid state students in the sense that because the crystal structures of all the main mineral groups have already been determined, the problem of finding trial structures does not arise for them, and is not examined in any detail, whereas a knowledge of the density and space group can give a great deal of information about the structures of crystals of known chemical composition. The author does deal with the reciprocal lattice, and with the taking and measuring of powder patterns, and also with rotation and oscillation patterns, having long ago recognized their particular value in teaching and in research. He has, rightly in my view, excluded moving-film methods from this introductory text.

The author starts from the premise that any understanding of minerals requires an understanding of crystal structure, and that this in turn requires an understanding of the concepts of morphological crystallography from which it arose. He also states that a number of novel features in the book have been developed by him in response to the difficulties and attitudes of students who are unlikely to have a primary interest in crystallography. Whether this is realism or defeatism is arguable, but one such successful innovation is the stereoscopic representation of some symmetry operations in fig. 3.2, and it seems a great pity that more stereoscopic drawings were not included. Another innovation is a start in reducing the number of special names used for faces of various forms $\{hkl\}$. Is it really still necessary to be able to count in Greek to describe the morphology of crystals?

In connection with one of the most important innovations, the omission of the Schoenflies notation, there is one small addition which would have increased the usefulness of the book in equipping the student to understand original papers dealing with known mineral structures, and that is a discussion of the reorientation of unit cells in relation to the 'standard setting' used in the International Tables for Crystallography. Although (p. 29) the unit cell vectors *a*, *b*, *c* are defined so as to constitute a RHS system, the importance of adhering to a RHS system does not seem to be sufficiently emphasized; there is no help for a student discovering that olivine is usually described in the space group *Pbnm*, which, since it is a non-standard setting of *Pnma*, does not at first sight seem to occur in the International Tables. This might be thought (erroneously) to provide an excuse for retaining the Schoenflies notation, and its final exclusion is alone enough to make this one of the first modern texts in the field, much to be commended.

The sections on irregularities, textures, and morphology revisited seem tantalisingly perfunctory, since, as the author well knows, many of the most challenging crystallographic problems lie in these areas, but in general the exposition is clear, the diagrams are good; there are problems and a glossary, and the approach is sufficiently analytical to enable students to make calculations detailed enough to inspire confidence in the power of crystallographic methods. It is thoroughly recommended.

H. JUDITH MILLEDGE

Prince, E. *Mathematical Techniques in Crystallography and Materials Science.* Berlin, Heidelberg, and New York (Springer-Verlag), 1982. viii + 192 pp., 28 figs. Price DM 55.00 ($25.60).

In his preface the author says that he has endeavoured to write not a textbook but a reference book—a vade-mecum for active research workers.

The topics to be included have been chosen on the basis of what the author has had to learn or look up frequently, or has been frequently called upon to explain to colleagues. The contents of the book are therefore somewhat idiosyncratic rather than all-inclusive, and not necessarily what all prospective readers would expect from the title.

Chapter 1 (19 pp.) introduces matrices, and these are applied in chapter 2 (21 pp.) to the symmetry of finite objects and in chapter 3 (8 pp.) to the symmetry of infinitely repeating patterns. Chapter 4 (10 pp.) introduces vectors, and deals with the reciprocal lattice, the orientation matrix, zones and forms, and sublattices and superlattices. Chapter 5 (19 pp.) introduces tensors and leads on to covariance and contravariance, multivariate normal distributions and their relationship to anisotropic temperature factors. The following three chapters are predominantly statistical. Chapter 6 (16 pp.) deals with data fitting and the concepts of robustness and resistance of fitting algorithms; chapter 7 (12 pp.) is on precision; and chapter 8 (14 pp.) covers the F- and t-distributions, correlation, and the propagation of errors. The final chapter 9 (15 pp.) is on constrained crystal structure refinement. There are also six short appendices (totalling 27 pp.) on eigenvalues and eigenvectors, the stereographic projection, generating matrices for superlattices, the probability integral and the gamma function, the harmonic oscillator in quantum mechanics, and symmetry restrictions on tensors of rank 2, 3, and 4. Finally in appendix G (27 pp.) there are listings of Fortran programs for some statistical functions and libration corrections.

Given the author's criteria for the choice of subjects one cannot directly criticize his choice, though one is surprised that there is no discussion of Fourier transforms. The purpose of the book means that it is aimed at a reader who already knows a little about a mathematical technique and wishes to know more about how to use it without being faced with rigorous proofs of its validity; it is not intended as a book to be read through, and a reviewer's approach to it is therefore inappropriate. The extent of this reviewer's prior knowledge varies from chapter to chapter, which is bound to affect his assessment of how successful each chapter is likely to be for its stated purpose. Different chapters certainly demand different amounts of prior knowledge for a full understanding, and will almost certainly drive most people to seek supplementary information or clarification elsewhere. Nevertheless this book will help them greatly to see how various techniques are related to what they know and to pin-point any further elucidation that they need.

The only general criticism of the book is that it is so concise: it would help more people if it led them through the topics rather more gently. But we all find some topics more troublesome than others. This reviewer always has trouble with character tables, and hoped that chapter 2 would dispel the mystery, but it did not. However that is a personal problem of the reviewer rather than a particular fault of the author. There are few errors, but the diagrams of the point groups would probably mystify or mislead anyone who was unfamiliar with them; the generators given for class *m3m* do not correspond with the Hermann-Mauguin symbol as stated; and there is an obvious omission from the first equation on p. 73.

A crystallographer would be unusually well mathematically informed if he did not find many things in this book that were useful. I certainly wish I had had it on my shelf years ago.

E. J. W. WHITTAKER

Gay, P. *An Introduction to Crystal Optics.* 2nd Edition. London and New York (Longman), 1982. x+262 pp., 120 figs., 1 colour pl. Price (Paper) £6·95.

Although in this re-issue only the bibliography has been updated, it is good to see available again this student text, now in paperback. It blends clear theoretical explanations with a thorough discussion of practical microscope techniques, including a chapter on the dispersion of the indicatrix and a section on interference effects for biaxial crystals in convergent light which fully describes the determination of the optic sign. Each chapter has a series of exercises (with answers at the end of the book) and a full-colour Michel-Lévy chart is also included.

R. A. HOWIE

Smart, P., and Tovey, N. K. *Electron Microscopy of Soils and Sediments: Techniques.* Oxford (Clarendon Press: Oxford University Press), 1982. xiii+264 pp., 145 figs. Price £45.00.

This book is a companion volume to *Electron Microscopy of Soils and Sediments: Examples* by the same authors. It covers an extremely wide range of preparative and analytical techniques for both scanning (SEM) and transmission electron microscopy (TEM), and should prove invaluable to any worker in the fields of soil and sediment study.

After two introductory chapters which describe the principles and uses of electron microscopy, there follow comprehensive accounts of drying and impregnation techniques, which include sufficient detail to be used directly as laboratory manuals. There is a further short section on the preparation of sample surfaces, and then a very full description