specifically excluded, but the petrogenetic aspects of both radioactive nuclides and stable isotopes (including geothermometry) are considered. It should be said that this chapter does not present such a full coverage of the subject as some of the others and possibly some would argue, in view of the fundamental importance of isotopic studies to recent advances in geochemistry, that this chapter could have been expanded. Much will depend on the approach to isotope geochemistry but, as now taught in many universities, it will probably be necessary to supplement this chapter with another text.

The final two chapters on the aqueous systems, covering continental and oceanic water, present in as succinct a manner as possible the chemical principles underlying weathering, ground water and element oceanic residence times. The final chapter in particular on chemical oceanography is a masterly summary of the speciation and reactivity of the components of sea-water.

The few criticisms that can be made of this book are almost entirely criticisms of what has not been included rather than what the book contains. Such criticism of omission are inevitable with a book of this type and will usually be of a subjective nature. The Introduction to the book clearly states areas the book does not attempt to cover—phase equilibrium relationships and isotope geochronology for example—and there are sound reasons for this approach. A more extensive account of the use of isotopes in petrogenesis would no doubt be welcomed by some, and the account of crystal fractionation using only the Skaergaard intrusion as a detailed example is rather limited. There is also no substantial mention of methods of obtaining the data of geochemistry, or indeed of evaluating such data. These comments are, however, quite trivial in comparison with the very real advance that this book will represent to many users. The coverage of principles in geochemistry is the book's greatest strength, examples are more easily found in the literature.

It is specifically aimed at something above the introductory level, and it assumes a knowledge of approximately first year undergraduate chemistry (and geology). It is clearly not intended as a general account of the subject. The approach is rigorous, authoritative and in parts, hard work. Those who hope to be led gently through the highways and byways of geochemistry will be disappointed. The overall standard of production is good, with few apparent errors and an extensive and up-to-date reference list. The index is comprehensive without being unduly long, and Pergamon have fortunately not repeated their previous unfortunate attempt to print from 'camera ready' typescript (see review *Mineral. Mag.* (1982) **42,** 146). The price for the hardback edition is reasonable by present day standards. The well-made 'flexicover' edition is splendid value and at this price even today's hard-pressed student or university lecturer should be able to afford at least this textbook.

In summary this fine book will be welcomed by all concerned with the subject. It should rapidly establish itself as the standard textbook, and its publication marks a very considerable advance in geochemistry.

J. N. WALSH

Saxena, S. K., ed. *Advances in Physical Geochemistry: Volume 2.* New York, Heidelberg, and Berlin (Springer-Verlag), 1982, x + 353 pp., 113 figs. Price $41.80 (DM 94.00).

The first volume of this series was subtitled *Thermodynamic of Minerals and Melts*, whereas Vol. 2 has three parts: *I. Ferromagnesian Silicates: Order–Disorder, Kinetics and Phase Equilibria; II. Melts, Fluids, and Solid–Fluid Equilibria; III. Thermodynamic Methods and Data.*

In Part I, Ghose and Ganguly consider in some detail the degree of ordering of Fe^{2+} and Mg in ferromagnesian silicates in different crystallographic sites. In chain silicates this ordering is quite pronounced even at fairly high temperatures and thus gives a useful indication of the cooling history of the parent rocks. The exsolution of pigeonite from augite in a sample of Skaergaard ferrogabbro is discussed by Kretz who estimates that such exsolution continued on cooling to around 750 °C and that Fe–Mg exchange between lamellae and host continued to around 540 °C; the dominant rate-limiting process in the exsolution reaction being the Cu–(Mg,Fe) exchange diffusion. The estimation of Fe–Mg site occupancies in *M*1 and *M*2 sites in clinopyroxene of intermediate composition is approached by Dal Negro *et al.* through crystal structure refinements, who consider that the compositional–structural parametric relationships make it possible to predict the bulk composition and site occupancies for crystals that have not been chemically analysed.

The three papers in Part II deal with the densities and structures of binary silicate melts (Gaskell), with the thermodynamics of supercritical fluid systems (Shmulovich *et al.*), and crystal–fluid equilibria in the albite–anorthite–water system (Blencoe *et al.*).

Three further contributions concerned with pyroxenes are presented in Part III, where Yagi, Mao, and Bell report the bulk modulus of hydrostatic compression of orthorhombic perovskite-type $MgSiO_3$. Saxena illustrates the computation

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.