(or subcell) of the structure as a guide to 'anisometricity'. The structures of individual sulphides and sulphosalts are then discussed in detail within the framework of this classification. This useful review of sulphide crystal chemistry contains a wealth of data and is illustrated with numerous structural diagrams.

The second half of the book is headed 'Phase Equilibria and Natural Assemblages' and starts with an exposition of general principles by which sulphides can be differentiated geochemically and crystallochemically into groups. Six assemblages defined in this way (Pt-Pd, Ni-Co-Fe, Zn-Cu-Fe, Cu-Sn-Pb, Ag-Au, and sulphosalt assemblages) are discussed in turn. Data are presented on the phase relations in the relevant systems and naturally occurring associations are briefly described. The former are illustrated with the appropriate phase diagrams and the latter with photomicrographs of polished sections. Again as in the section on crystal chemistry, a large amount of information has been brought together and, although individual occurrences are only briefly described, the salient points are covered and references to more detailed accounts are provided.

A final section comprised of just over three pages is entitled 'Systematics' and attempts to combine the crystal chemical and geochemical classifications into an overall classification scheme for the sulphide minerals. In what is, in effect, a twenty-eight page appendix to this chapter and to the book as a whole, all sulphide and related minerals known up to the end of January 1981 are listed within the framework of this classification. As well as mineral name and formula, symmetry and unit cell parameter data are also provided. More than four hundred references are listed at the end of the book and there is an index of mineral names which also lists the major lines in the X-ray powder diffraction pattern. Unfortunately, there is no general subject index.

This book is well produced with few typographical errors and an attractive binding. For a slim volume, it contains much valuable information on the crystal chemistry, phase relations and occurrence of sulphide and sulphosalt minerals. Anyone involved in research on the sulphide minerals will require a copy on their bookshelf.

D. J. VAUGHAN

Henderson, P. *Inorganic Geochemistry*. Oxford (Pergamon Press), 1982. 353 pp., 104 figs. Price £21·00 (£9·25 in flexicover).

There is no shortage of books on geochemistry, the shortage has been in geochemistry books that could be recommended, notably for those reading the subject at anything beyond an introductory level. The 'classic' texts by Goldschmidt (and by Rankama and Sahama), both now out of date and out of print, have not been replaced by comparable modern accounts of the subject. The only other book that could reasonably claim to be a standard textbook for the subject—Mason's *Principles of Geochemistry* first published in 1952—although revised and updated, cannot be regarded as an advanced textbook covering recent developments in the subject. Hence the publication of an entirely new textbook in geochemistry by one of the foremost researchers in the field is an event of some importance.

The book addresses itself to 'senior undergraduates in the Earth sciences and for students doing postgraduate courses in geochemistry . . . the seasoned researcher and to the university lecturer'. A threefold division of the subject is made: (1) the chemical composition and nature of the Earth, Moon, and meteorites; (2) chemical principles in igneous and metamorphic systems; and (3) aqueous systems for continental and oceanic waters. Within these major divisions are several chapters on specific aspects of geochemistry, presenting concise and comprehensive summaries of current thinking in these fields.

Part One includes chapters on meteorites, cosmic abundances, and the Earth—including discussion of the chemistry of the major divisions of core, mantle, and crust. There is also a most welcome chapter summarizing the implications of recent discoveries on the geochemistry of the Moon. This is an excellent account of a topic where our knowledge has been transformed in recent years, and geochemist and non-geochemist alike may consider buying the book for this chapter alone.

It is in Part Two that one sees most clearly the evidence of original thinking and a new approach to the subject. Chapter 5 presents the data of element distribution and chapters 6, 7, and 8 evaluate the structural, thermodynamic and kinetic controls of element distribution. These last three chapters are written at an advanced level and are substantially more 'quantitative' in approach than anything previously attempted in a standard textbook. They should be of great value to researchers in the field and will do much to encourage a more rigorous treatment of geochemical data. Much of the discussion in these chapters uses examples of igneous rock processes, and as the author points out, our knowledge of element mobility during metasomatism is much more limited. Part Two of the book also includes a chapter on some geochemical uses of isotopes, which has been a significant and regrettable omission from most previous geochemistry textbooks. Isotope geochronology is

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