BOOK REVIEWS

Fyfe (W. S.), Price (N. J.), and Thompson (A. B.). *Fluids in the Earth's crust* (Developments in Geochemistry, I). Amsterdam, Oxford, and New York (Elsevier), 1978. xviii + 383 pp., 225 figs., 1 coloured pl. Price Dfl 125.00 ($49.75).

The subject matter of this volume is, in the opinion of this reviewer, likely to be one of the most important fields of study in the Earth Sciences as a whole during the next decade. Whether we are concerned with the degassing of the Earth, mechanisms of heat transfer during regional metamorphism, the scavenging of useful elements from large volumes of crust and their concentration into orebodies, or the mechanical properties of crust during deformation, in every case we come back to questions of the nature of crustal fluids, their transport characteristics, and their distribution. The present volume does a valuable service by drawing attention to many of these problems.

The authors cover a wide spectrum of topics. The early chapters deal with the character and chemical behaviour of aqueous fluids from a great variety of environments, volatiles in minerals, and solution chemistry. This makes up about a quarter of the book. The second quarter is largely concerned with metamorphism, reaction rates, dehydration, and decarbonation during metamorphism, the buffering of fluid systems, and partial melting. The second half of the book deals principally with the effects of fluids on the mechanical properties of rocks and some of the physical aspects of the behaviour of rock fluids. Even diapirism merits a chapter. Finally there is a synthesis chapter in which many of the diverse threads of the story are drawn together.

The concept of the book is excellent and it is most thought provoking to have a unified treatment of subjects which are all too often regarded as entirely separate. On the other hand, the book does have a number of shortcomings. Perhaps the most serious is that which the authors could do least about. Having conceived the volume at a time when they were involved in a joint research project and, no doubt, met frequently, the book was completed after they had dispersed to different institutions. The result inevitably is that the different parts do not hang together as well as they might, and have rather different levels of approach; although it must be admitted that in an interdisciplinary volume of this kind it is very hard to define a 'uniform level'.

The final production of the book also merits criticism. For the price asked, far too many errors were missed by the proof-readers, some sufficiently serious to mislead a student who is already finding the text hard work. The publishers have in too many cases crammed too many small and complicated diagrams on to a page, or simply reduced diagrams too far.

The important thing, however, is that the book has been written. It should be widely read and should change the thinking of those who read it. The reviewer would in one respect like to change the thinking of the authors who, every time they need to show a geothermal gradient on a diagram, do so in the only way which is unquestionably wrong, i.e. by drawing a straight line!

This text is appropriate for use by final-year undergraduates and research students with a reasonable grounding in physical chemistry and thermodynamics. It should be in the library of every university.

E. R. OXBURGH

Farah (A.) and De Jong (K. A.), Editors. *Geodynamics of Pakistan.* Quetta (Geol. Surv. Pakistan), 1979. x + 362 pp., 206 figs., 6 geol. maps. Price R80.00 (+ postage).

This well-produced and well-illustrated book results from a programme sponsored jointly by the Pakistan Government and the National Science Foundation of the USA. The initial results presented here include 27 papers by 42 contributors (for details see M.A. 80-0077), of whom 29 are from outside Pakistan. The main emphases are on ophiolites, plate tectonics, and the geology of northern Pakistan.

R.A.H.

Marfunin (A. S.). *Physics of Minerals and Inorganic Materials: an introduction.* Berlin, Heidelberg, and New York (Springer-Verlag), 1979. xii + 340 pp., 138 figs. Price DM 98.00 ($53.90).

There is certainly a need at the present time in Mineralogy for texts which clarify and illustrate the many branches of physics which are currently important in the development of the subject. To be really successful they must be written sympathetically but, at the same time, the fundamental physical and mathematical concepts involved must be clearly explained. In this context Marfunin's book, which deals essentially with the electronic structure of atoms, atom clusters, and crystals, is only partly successful. The subject matter is essentially quantum mechanics and is based on group theoretical

principles. It is impossible to provide a really satisfactory treatment of the subject without a brief but specific survey of the relevant group theoretical methods. From this point of view Marfunin's treatment compares rather unfavourably with other textbooks and particularly with that of Heine (Group Theory in Quantum Mechanics, Pergamon, 1960) which covers the same subject matter but also explains all the necessary group theoretical principles.

This book begins with a historical account of the development of quantum theory as applied to the electronic structure of single atoms, and includes reference to the old quantum theory and the Bohr model of the atom. The role of Schrodinger's equation and the emergence of modern quantum theory of the atom follow, and lead to quantum number solutions for atomic orbitals. This chapter is very well illustrated and the mathematical treatment is clearly set out. It is unfortunate that equation numbers referred to in the text have inadvertently been omitted over several pages of the mathematical development.

The second chapter considers the influence of site symmetry on the degeneracy of the free atom orbitals in the crystal field approximation, and deals with the splittings which occur in octahedral, tetrahedral, and cubic environments. Irreducible representations of the relevant point groups are introduced here with little in the way of explanation and the situation is somewhat unsatisfactory since a number of the important principles involved are omitted. (A mistake occurs in the representation table for point group C_{4v} (Table 11) where the character of the identity element is entered as $+1$ rather than $+2$ in the final ,(E), representation.) This chapter also contains a complete listing of the relevant irreducible representations for different point group symmetries (Table 14) and a set of formal rules for the direct product representations, in the context of allowed optical transitions in spectroscopy (Table 16). Crystal field splitting effects are illustrated in this chapter by reference to the iron group elements. The chapter ends with the discussion of weak splitting effects associated with spin-orbital interaction and the Jahn–Teller effect. The explanation of Jahn–Teller phenomena given is far from clear, and the interested reader would do well to consult the original paper for a clear explanation of the origin of this loss of degeneracy.

Chapter Three deals with the next stage in complexity in relation to electron structure, namely that of clusters and molecules. Here the relative merits of molecular orbital and valence bond theory are compared in the context of their historical development. The uses of molecular symmetry and the corresponding irreducible representations are illustrated. At this point the author proceeds to methods of calculation. The use of the secular equation and the origin of coulomb, exchange, and overlap energies are detailed. Molecular orbital calculations are provided for octahedral and tetrahedral complexes of transition and non-transition elements. The chapter finally returns to a discussion of the merit or demerit of classical bonding concepts, and the limitations of such methods in the context of valence and charge distributions.

Chapter Four constitutes the final step in the theoretical development, and deals with electrons in crystals, where electron distribution may extend throughout the crystal and is subject to the translational group characteristics of the whole lattice. In treating the fundamental symmetry aspects of the resulting band structure in the crystal the author has listed the symmetries at different symmetry points in the Brillouin zone. It would have been particularly useful here to deal with an actual example, and to provide character tables to illustrate the degeneracy and symmetry of a single energy band throughout the Brillouin zone. Spin-orbit coupling is given a brief mention, but the theory of the relevant double groups is dealt with rather superficially. This chapter ends with an account of the known band structure schemes for MgO and a number of other simple compounds. The role of band structure in relation to reflectivity spectra of minerals is also discussed. In this chapter there is a rather misleading reference to the nature of the Fermi surface (page 161), and the separation of reciprocal lattice points is wrongly stated as π/d instead of $2\pi/d$ (p. 167).

Chapter Five provides an account of the role of solid state spectroscopy in the study of electronic structure and the chemical bond, and represents material which must be covered in much greater detail in a companion volume by the same author (see below).

Chapter Six is concerned with optical absorption spectra and the nature of colour in minerals. It commences with a clear account of the practical aspects of the measurement of absorption, and diffuse reflectance, spectra. Types of absorption spectra are discussed and the relevant selection rules are given. This section is followed by a detailed and lengthy account of the experimental study and analysis of transition ion spectra.

Chapter Seven is devoted to the difficult problem of calculating energies for the chemical bonds in minerals, and bond orbital calculations for the silica polymorphs cristobalite and quartz are used as examples. The discussion then reverts to a general analysis of lattice energies for ionic crystals and the relevance of atomic, orbital, and mean radii in crystal structures. The chapter ends with an

account of the determination of atom sizes in MnO_4^- based on energy band theory.

The final chapter is devoted to a discussion on the nature of the chemical bond in some classes and groups of minerals and contains a clear statement of the author's thesis that ultimately the only satisfactory description of bonding which can be made must be based on the molecular orbital and energy band theories. This concept, in as far as it is currently possible, is then applied to the silicates, beginning with the nature of the chemical bond in SiO_4^{4-}, and using data both from X-ray and ESCA spectra. The treatment proceeds in outline to other cation polyhedra in silicates. This is followed by a wide-ranging discussion of the nature of the bonding in sulphides in the context of their energy band structures. The chapter ends with a very brief account of the hydrogen bond.

While this book is superficially extremely well produced and will certainly be much used for the data which it contains it is somewhat surprising that the standard of writing and editing is so poor. With a good knowledge of English it is usually possible to guess what the author means and it is perhaps unfair to be too critical in this context. However, the book, in addition, is full of avoidable misprints and it has clearly been very inadequately proof-read. I find if difficult to understand how a publisher, in presenting a book on the international market, and at a very high price, should fail so miserably on the simple matter of spelling.

J. D. C. McCONNELL

Marfunin (A. S.). *Spectroscopy, Luminescence and Radiation Centers in Minerals* (transl. from the Russian by V. V. Schiffer). Berlin, Heidelberg, and New York (Springer-Verlag), 1979. xii + 352 pp., 170 figs. Price DM 108.00; $59.40.

This is the second book on mineral physics by the Russian author A. S. Marfunin to appear this year. The first (*Physics of Minerals and Inorganic Materials*) is reviewed above. As the title implies, the second volume deals with some of the less familiar spectroscopic methods, namely Mössbauer, nuclear magnetic resonance (NMR), nuclear quadrupole resonance (NQR), X-ray spectroscopy, luminescence and thermoluminescence, and the properties of electron-hole centres. The arrangement of each of the six main sections is similar, with a description of the theory and general principles of the method being followed by a discussion of its applications to minerals. There is a list of 1023 references, classified according to the spectroscopic method used, and an adequate index.

The section on the Mössbauer spectroscopy is typical. Three of the 37 pages describe the basic theory of the Mössbauer effect and 15 the experimental arrangement, the types of spectra, and the origin and meaning of the isomer shift, quadrupole splitting, and hyperfine splitting. The remaining 19 pages are devoted to the Mössbauer spectra of minerals, notably silicates, oxides and hydroxides, and sulphides. There are 235 references, all but a few pre-1977. The whole constitutes a good introduction to Mössbauer spectra for the non-specialist, and a useful summary for the mineralogist specializing in this field.

The remaining sections, of which that on luminescence and thermoluminescence (101 pp., 271 refs.) is the longest, and that on NMR and NQR (22 pp., 101 refs.) is the shortest, follow a similar pattern. Taken with the accounts of electron paramagnetic resonance (43 pp., 148 refs.) and X-ray spectroscopy (38 pp., 95 refs.), they provide an extremely useful introduction to these less-known spectroscopic methods, and particularly to their mineralogical applications, and deserve to be widely read and applied.

In view of the scientific merits of the book, it is a pity that the author has been let down by his publishers, who have devoted insufficient effort to editing the translation and to proof reading. It is usually possible for the reader to discover what the author must have meant, but the path to enlightenment is made harder by the peculiar Teutonic phrasing and word-order that is often adopted, and by the incorrect use of words, e.g. 'negligent' for 'negligible'. Foreign companies publishing in English would do well to have their translations edited by native speakers of that language, even if the translation is done by others. The proof-reading is poor, with 'sheelite' (scheelite) throughout §7.3.13, and an unreasonably high concentration of other errors.

Despite these defects, the book is to be welcomed. Perhaps the second edition will be better produced.

R. G. J. STRENS

Barrer (R. M.). *Zeolites and clay minerals as sorbents and molecular sieves*. London and New York (Academic Press), 1978. viii + 497 pp., 181 figs. Price £25·00.

It is unfortunate that this review of an important monograph was delayed by late receipt of the review copy: apologies to Professor R. M. Barrer!

One of the great commercial successes in recent years has been the development of zeolites and clay minerals as sorbents and molecular sieves, not to mention parallel applications of zeolites as ion-exchangers and catalysts. The crisis in petroleum