fabrics; controls on crystal morphology, inclusions, intergrowths, coronas and replacements; accounts of deformation mechanisms and the influence of strain (including the use of shear-sense indicators); explanations of porphyroblast inclusion patterns and relationships with the matrix; development of vein infills and fluid inclusions; and finally interpretation of polydeformed and metamorphosed rocks.

Thus the book attempts to view metamorphic rocks in their true context: as rocks very strongly influenced by deformation processes and disequilibria not just those relating to temperature and pressure variations and idealised equilibrium conditions. The aim is admirable but because the author has tried to compress accounts of all the phenomena involved into a 'concise and inexpensive' text he has had to leave many explanations aside or state them too briefly, and he has been selective, in some sections, of the phenomena that should have been discussed. This problem is however common to many geological texts that try to save the student money by being brief; emphasis is placed on description rather than explanation, and reference to the literature is minimised—surely a sad situation but inevitable in view of the spread of the free-market disease.

The author's summaries of types of metamorphism, facies, grade, crystal growth and the characteristics of the main compositional groups of metamorphic rocks though brief, are clear and will be useful to the undergraduate. However discussions of the variety and origins of rock fabrics are too brief and incomplete. The emphasis placed on the role of simple-shear is misleading and could give undergraduates the impression that this is the only type of deformation that metamorphic rocks suffer. Reference to the strain ellipsoid in this section, and elsewhere, is made without an adequate discussion of its geometry and significance. Also, diagrams and photographs are sometimes not adequately labelled. Undergraduates will I think struggle to understand deformation mechanisms particularly in the absence of clear illustrations. Whilst possibly not the author's fault it is a pity that some of the black and white photographs have not reproduced too clearly and many are rather small, even though there is ample space on the page to enlarge them.

Despite these criticisms the book is a welcome addition and will undoubtedly be useful to all students of metamorphic geology—there is no alternative to my knowledge and on most counts it is preferable to Spry's earlier text. Hopefully if revision becomes possible the author and publisher would consider considerable expansion.

D. POWELL

Lipin, B. R. and McKay, G. A., Eds. *Geochemistry and Mineralogy of Rare Earth Elements*. Washington, D.C. (Mineralogical Society of America: Reviews in Mineralogy, Vol. 21), 1990. x + 348 pp. Price $20.00.

The *Reviews in Mineralogy* started in 1974 as Short Course Notes and since then have rightly earned a good reputation. This volume, the 21st, is a worthy addition to the series, with eleven chapters covering the geochemistry of the rare earth elements in mineralogical, igneous, sedimentary and metamorphic systems [M.A.90M/4247–4257]. There is also an appendix on cathodoluminescence emission spectra of rare earth element activators in minerals.

The approach of the book is mostly along traditional lines—dividing the subject into cosmic and lunar systems, the principal rock groups, minerals, and isotopic studies. This has led to some repetition—we are quite often told about ionic radius and how this affects the distribution of the rare earth elements (*REE*), and basalts are discussed in five of the chapters. The book starts with a well-written chapter by W. V. Boynton on cosmochemistry. He spells out clearly the differences between nebular and planetary processes and gives the basis for the quantitative calculation of *REE* condensation. A final section summarises the information that *REE* studies have given us—especially about the solar nebula. P. J. Patchett has a short chapter on isotope geochemistry, with frank statements on the applicability and limitations of the methods. The emphasis is on studies of crustal evolution, in which Nd isotopes have had a significant impact. There is little on the use of combined Sr–Nd isotope studies and the important work of some research groups (e.g. Hawkesworth's) receives no mention.

A well-structured chapter on *REE* partitioning between minerals and basaltic melts, by G. A. McKay, discusses first principles as well as some current problems. G. N. Hanson gives a short account of trace element modelling, a lot of which is to be found in other standard texts on geochemistry or petrology. He shows how *REE* data trends can be used to differentiate between batch melting and fractional crystallisation in magmatic processes. This is followed by an extensive survey of *REE* in upper-mantle rocks by W. F. McDonough and F. A. Frey. It builds on an earlier (1984) review by Frey and deals with massive peridotites, ultramafic xenoliths, megacrysts and inclusions. Its purpose is to demonstrate how *REE* data can be used to understand and constrain upper-mantle processes. This is well achieved and although the chapter is one of

the longest, interest is held through the somewhat didactic style.

There have been few reviews of *REE* in metamorphic rocks, so the one here by R. I. Grauch (with its good reference list) is especially welcome. The data on the residence and mobility of *REE* in metamorphic rocks are critically discussed and it is also made clear that at present these elements have only a very limited use in elucidating the details of closed-system metamorphism. Two chapters—the first by S. M. McLennan on sedimentary rocks, the second by D. G. Brookins on aqueous geochemistry—deal with the topics of weathering, diagenesis, provenance studies, complexing and Eh-pH diagrams, among others. There is some overlap in these two chapters which is a pity when space in a book such as this is at a premium. L. A. Haskin uses the magma ocean model to introduce the reader to *REE* patterns of lunar materials and how they fit into the ideas on rock genesis. His treatment of the subject is fresh and he writes with obvious enthusiasm. A chapter on compositional and phase relations among *REE* minerals by D. M. Burt is more unusual, dealing as it does with exchange vectors of element substitution. The approach seems to be a particularly good one for the complex exchanges that can occur in some of the mineral groups. The book ends with a chapter on economic geology by A. N. Mariano. It covers the relevant minerals and a classification, with brief descriptions, of *REE* deposits in carbonatites.

The editors have managed to gather together a good group of authors and the volume is recommended. The point is made that *REE* geochemistry cannot be taken in isolation when studying rocks or minerals, but nonetheless students will find the chapters on partitioning (Ch. 3), upper-mantle rocks (Ch. 5) and lunar materials (Ch. 9) especially helpful and in a broader context than just the *REE*. Researchers and specialists will be thankful for the other chapters as well. The only significant criticism on editorial control is that more effort should have been made to avoid duplication of material—some of which has been mentioned here.

The topics that are included are generally covered well. It is in the newer areas of *REE* geochemistry that the book is disappointingly thin. For example, there is virtually no discussion on the hydrothermal transport and deposition of *REE* in such systems as skarns or pegmatites and the interpretative uses to which the *REE* data can be put. Carbonatites are treated only from an economic viewpoint and alkaline igneous rocks not at all, although both are important as *REE* hosts. Despite these and other omissions, the book acts as a good introduction to the subject and will undoubtedly be purchased by many. Its use would probably have been even greater if a subject index had been provided.

P. HENDERSON

Anthony, J. W., Bideaux, R. A., Bladh, K. W., and Nichols, M. C. *Handbook of Mineralogy: Volume I; Elements, Sulfides, Sulfosalts.* Tucson, Arizona (Mineral Data Publishing), 1990. viii + 588 pp. Price $82.50 + $5.00 shipping and handling.

As the name implies, this (bulky) volume is a compilation of data on minerals aiming, in the words of the authors, to 'gather in convenient form the data crucial to identification of all mineral species and to provide definition of each species'. To this end, one page is devoted to each of 588 mineral species belonging to the families of elements (including alloys and intermetallics), sulphides (including other chalcogenides) and sulphosalts (including sulphoxides and sulphalides). The minerals are listed alphabetically by name and the format of presentation is consistent throughout. With the name is given an idealized chemical formula and then information listed under the following headings: crystal data, physical properties, optical properties, cell data, X-ray powder pattern (up to seven most intense lines), chemistry (analyses with calculated formula), polymorphism and series (noted as appropriate), occurrence, association (i.e. associated minerals), distribution (most important localities), name (significance and origin), type material (i.e. Museum holdings of type material) and references (i.e. citations used to define the data summary for the species). This is intended to be the first volume of a five volume series, future volumes dealing with silica and silicates (Vol. II); halides, hydroxides, oxides (Vol. III); arsenates, phosphates, uranates, vanadates (Vol. IV); borates, carbonates and sulfates (Vol. V).

The compilation of so large a body of data is a formidable task, and the authors are to be congratulated on embarking on such a project. The data contained in this first volume will be of considerable value to researchers and professional mineralogists. It certainly is not a text to put before students or those with a more casual interest in mineralogy (it contains no drawings, illustrations or tables and very little explanation of the data presented). To the extent that no comparable modern compilation exists, it is a valuable addition to the literature. However, in a