BOOK REVIEWS

Drits, V. A. *Electron Diffraction and High-Resolution Electron Microscopy of Mineral Structures*, Berlin, Heidelberg and New York (Springer-Verlag), 1987. xii + 304 pp. Price DM248.00.

This is an English version of the Russian original published in 1981. However, it has been expanded and updated to include recent examples (up to 1986) of the study of mineral structures by the two techniques.

The translation, on the whole, is good, but the book remains very difficult to read. This is partly because it is very mathematical (most mineralogists are not physicists) and the symbols used are often not the standard ones that western electron microscopists use. The worst aspect, though, is the diagrams. They are often poorly produced and the annotation and captions are inadequate. The ray diagram of Fig. 13a is incorrect as the rays do not come to a focus in the second image plane!

The aim of the book is to explain the use of electron diffraction and high-resolution electron microscopy (HREM) in determining the crystal structure of materials. The vast majority of electron microscopists (including the relatively small number of mineralogists) do not use electron diffraction for this purpose; rather they use it as an integral part of microscopy to characterize phase distributions, defects, etc. X-ray diffraction is a far more straightforward technique for the determination of crystal structures, except when the material is fine-grained or poorly crystalline. It is for these materials (whether they be natural or synthetic) that the techniques described in this book are ideal. As much of the development and use of the techniques has taken place in the USSR and much of the literature is in Russian, western scientists concerned with fine-grained and poorly-crystalline materials will find this book useful, despite its limitations.

The bulk of the book is concerned with diffraction (207 out of 284 pages). The first three chapters cover the direct and reciprocal lattices, the determination of the unit cell and space groups from electron diffraction patterns and the kinematical theory of electron diffraction. A notable omission here is convergent-beam electron diffraction, a technique developed by groups in Australia and Great Britain, which can provide space group information in a relatively straightforward way. The use of Kikuchi patterns to orient the crystal exactly along a zone axis is not mentioned either.

Chapter 4 describes structure analysis by electron diffraction. The methods are identical to those used for X-ray diffraction, except that the distribution potential is plotted instead of the electron density. Patterson projections can be constructed from the intensities. For other methods, phases must be obtained either from a trial structure, a high-resolution image or, if the crystal is sufficiently thin that dynamic effects can be ignored (typically 50–100 Å in a single crystal), directly from the intensities themselves. A mention could have been made here of the current development of methods for the determination of atomic positions using convergent-beam techniques.

Chapters 5 and 6 cover the dynamical theory of electron diffraction. In Chapter 7, which is devoted to high-resolution imaging, the effect of aperture limitation, spherical and chromatic aberration, defocus and beam divergence on the image are discussed, together with the concept of a pseudo-weak phase object.

Oblique-texture electron diffraction has not been much used in the West. This is a powder technique in which the dispersed sample is tilted so that each powder ring intersects the Ewald sphere as two short arcs. Chapter 8 describes the method in detail and a number of examples of its application to the determination of the structures of clays and micas are given. While X-ray diffraction from single crystals gives more accurate results, many minerals do not occur in a suitable form for such work. OTED is then the most accessible technique.

The remaining three chapters of the book are devoted to applications. Chapters 9 and 10 give some examples of the use of SAED and HREM in the study of mixed-layer minerals, micas and phyllosilicates, while Chapter 11 describes the spectacular work, carried out mostly in the USA, on multiple-chain and mixed-chain silicates. As the author says 'the main contribution of HREM to structural mineralogy' is 'in the study of real crystal structure including miscellaneous types of imperfections'.

P. E. CHAMPNESS

Smyth, J. R. and Bish, D. L. *Crystal Structures and Cation Sites of the Rock-Forming Minerals*. London and Boston (Unwin-Hyman Ltd.), 1988. xx + 332 pp. Price £30·00.

This book presents a wide range of crystallographic data on the major minerals. After a short introduction, the reader is presented with over 300 pages of data tables and figures of major oxides, hydroxides, silicates (subdivided into orthosilicates, chain silicates, framework silicates, etc.), carbonates, nitrates, sulfates (*sic*), phosphates and halides.

The crystallographic data presented includes formula, density, space group, cell parameter, cation coordination number, Wyckoff position, fractional coordinates, bond lengths, polyhedral volume and electrostatic site energy. In addition, a source reference for each structure is given. The full page figures are largely polyhedral drawings of the structures, and are generally very clear.

The book is intended for petrologists and geochemists interested in understanding the geochemical behaviour of minerals in terms of their atomistic structure. From this point of view the work may well prove a useful source of data. I cannot help feeling, however, that by omitting the fractional coordinates of the anionic species, this book has fallen short of being an invaluable data source, and is likely to have only limited appeal. Admittedly, including anionic coordinates would have considerably increased the amount of data, but I believe it would have been well worth doing. As it stands this book is interesting, but not an essential addition to the library of every mineralogist.

G. D. PRICE

Frey, M. (ed.). *Low Temperature Metamorphism.* Glasgow (Blackie), 1987. x+351 pp. Price £45·00.

The study of 'low-temperature metamorphism' or low- to very low-grade metamorphism is an area that has been largely neglected by British geologists. This partly reflects the long-standing debate as to whose realm the subject falls into, generally being considered too high a temperature for those involved with diagenetic investigations, and too low a temperature for metamorphic petrologists. The truth of the matter of course is that there is a continuum.

The study of low-temperature metamorphism is itself a very young branch of the Earth Sciences, dating from the pioneer work of Coombs and others in the mid to late 1950s. While there has been a limited attempt in recent years to redress the balance by some British geologists, still the majority of work in this field is undertaken by investigators in other countries; this is clearly reflected by the contributors to this volume.

This book provides an authoritative review of the subject in question, with the relevant chapters all being written by recognized authorities in their field. The very nature of the subject demands input from many different disciplines within the Earth Sciences, which is demonstrated by the diverse topics covered in the book.

The first chapter (by Frey and Kisch) describes the realm of the book, highlights problems of definition in low-temperature metamorphism, and discusses aspects of terminology. Chapter 2, by Frey, describes how metamorphic grade at these low temperatures may be determined utilizing clastic, principally pelitic, rocks. Textural developments, the various crystallinity indices utilized, aspects of polytypism and polymorphism, clay mineral assemblages, and geothermometry and geobarometry are detailed. Mineral assemblages and mineral facies in low-grade volcanic and volcaniclastic are described in Chapter 3 by Liou, Maruyama and Cho. Their discussion largely relates to the model NCMASH system as developed by the authors, which must represent one of the most significant developments in low-grade metamorphic studies in recent years. Chapter 4, by Teichmüller, gives an account of low-grade metamorphic effects on organic materials. Details of the types of organic matter in sedimentary rocks are followed by a description of the processes of coalification, anthratization and graphitization, and the rank and stage parameters. Fluid inclusion investigations in low-grade metamorphic studies are reviewed by Mullis in Chapter 5. An introductory description of methodology is provided, followed by accounts of estimation of fluid composition and density, and aspects of geothermometry and geobarometry. In addition various case studies are reported. Chapter 6, by Hunziker, is an appraisal of radiogenic isotopes in low-grade metamorphic studies. A review of the problems of isotope studies in low-grade metamorphic terrains is followed by a description of the principal techniques utilised (K–Ar, ^{40}Ar–^{39}Ar, Rb–Sr, fission track dating, U–Th–Pb and Pb–Pb). The final chapter is an extensive review by Kisch on correlation in low-grade metamorphism, a chapter of enormous value given the diverse courses of low grade metamorphic investigations. In particular Kisch correlates illite crystallinity, metabasite mineral assemblages, and coal rank. As in other reviews by this author he provides invaluable exhaustive reference to other published works. Finally a most comprehensive and up-to-date reference list is provided.

In conclusion this book is to be recommended to anyone who has a research interest in low-grade metamorphic investigations. The various contributions are authoritative and well written