BOOK REVIEWS

McLaren, A. *Transmission Electron Microscopy of Minerals and Rocks*. Cambridge (Cambridge University Press), 1991. 387 pp., 188 figs. Price £50.00 ($75.00).

Alex McLaren has written an account of his extensive research, spanning the last thirty years, into mineral microstructures, particularly the framework silicates. Although at first glance it appears to be a compilation of McLaren's published papers, upon actually reading the text I found the book to be a refreshing and original attempt at presenting the theory behind image formation in the transmission electron microscope (TEM). The author clearly states that the book is specifically designed for geologists and mineralogists who may have studied physics only at the first year university level. The book is primarily an introduction to basic principles of electron microscopy—not a practical manual. One might argue that a practical manual is exactly what geologists and mineralogists really need in order to use efficiently the power of electron microscopy as a research tool. I myself am a firm believer that learning TEM is like learning a new computer operating system, you can't do it without the computer in front of you.

McLaren begins his book with an interesting historical introduction to imaging, first with light and then with electrons. He then describes the first significant application of TEM (in 1963) to an important rock-forming mineral, alkali feldspar. It is unfortunate that he neglects the preceeding twenty-five years of research on clay minerals that fully utilised the capabilities of the TEM for small particle imaging and diffraction. Perhaps that is my greatest criticism of the book, his rather uneven handling of the types of mineralogical studies that have been accomplished with TEM. But this probably reflects the fact that Washington is on the other side of the world from Canberra.

The first half of the book is devoted to the physics of the transmission electron microscope and with the basic theories required for the interpretation of images and electron diffraction patterns. This is an expanded version of his chapter in 'Applications of Electron Microscopy in the Earth Sciences' published by the Mineralogical Association of Canada. The mathematics are minimal although some knowledge of crystallography is required. Unlike most texts that begin with electron wave theory, McLaren starts with the principles of image formation by a lens, a glass lens in this case. From this he takes you through a set of experiments using a laser and TEM grid to illustrate the concepts of the image and diffraction modes. Chapter 2 briefly describes the transmission electron microscope while Chapter 3 and 4 introduce the kinematic and dynamical theory of electron diffraction in crystals. If a mineralogist or petrologist needs to understand the generation of contrast in the TEM they certainly need to understand these two theories, otherwise they are only taking pictures. I think this part of the book is outstanding. There are many attempts to point out important aspects of the theory and a very detailed analysis of how to calculate the diffracted and transmitted intensities. Chapter 5 uses this knowledge to understand the contrast that arises while viewing crystal defects, such as faults, twins, dislocations and strain fields from inclusions. Chapter 6 devotes only 12 pages to phase contrast imaging or high resolution TEM (HRTEM) as it is popularly known. This reflects the author's strong interest in two-beam or amplitude contrast imaging. I don't have any difficulty with that view. A brief survey however does show that phase and amplitude contrast images are equally abundant in the mineralogical literature. Chapter 7 is a short discussion of chemical analysis using the TEM with only a mild warning of the instrumental and analytical difficulties of this technique. There is little or no discussion of the increasingly popular technique of convergent beam diffraction.

The second half of the book is devoted to mineralogical applications in undeformed and deformed minerals. The analysis of the contrast arising from Brazil and Dauphiné twin boundaries in quartz is classic and required reading for any mineral physicist interested in the alpha/beta quartz transition. There is however no discussion of the incommensuate phase. The origin of diffraction contrast from faults and twins in wollastonite and albite and antiphase domain boundaries in anorthite is explained in detail and will be useful for students attempting to understand these features. There is also a good compilation and discussion of the contrast arising

from radiation damage by electrons, neutrons and decay particles.

The final quarter of the book is about microstructures arising from deformation. McLaren was directly involved in the early work (1960's) on dislocations in quartz and this chapter clearly shows his continuing interest. After discussing the fundamentals he illustrates them in quartz, feldspar, calcite, dolomite, olivine, pyroxene and perovskite. He completes the chapter by relating the deformation microstructures to geologic processes. No space is given to diffraction contrast from shock-induced microstructures which would be especially useful at this time of cometary impacts and dinosaur extinctions.

I found myself of two minds after reading the text: (1) I wished McLaren had covered the field more evenly or (2) had expanded on the explanations of diffraction contrast for those examples he did cover. He could have written an excellent practical manual. It is clear that this book is strongly oriented toward amplitude contrast imaging, framework silicates and deformation microstructures. It is well illustrated with 188 figures, features a detailed account of imaging theory and in spite of what McLaren states is filled with practical imformation about TEM, mineralogy and rocks. It definitely belongs next to the classic and useful texts of Hirsh, Howie, Nicholson, Pashley and Whelan; Edington; and Wenk.

The book will be especially useful as a supplement for graduate students learning microscopy as well as researchers wishing a compilation of McLaren's research efforts which are extensive, instructive and carefully done. The price is high and Cambridge University Press would do well to bring it out in paperback for the significantly lower price I paid for the paperback edition of the third volume of Putnis and Liebermann's Cambridge Topics in Minerals Physics and Chemistry. This would bring the price closer to the reviews published by the professional societies and within a student's reach.

G. L. NORD, JR.

Mange, M. A. and Maurer, H. F. W. *Heavy Minerals in Colour*. London (Chapman and Hall), 1992. 147 pp. Price £50.00

The stated aim of this book is to provide a manual to assist in the microscopic identification of the most common heavy minerals in sediments. Three-quarters of the book is dedicated to detailed descriptions and illustration of 61 transparent mineral species. The descriptions are clear and concise, and the colour photographs are excellent. For any sedimentary petrographer who has struggled with heavy-mineral grain identification using descriptions, line drawings and black-and-white photographs in texts such as Milner's Sedimentary Petrography this atlas of heavy minerals comes as a very welcome aid. Each mineral is illustrated by a grain mount consisting of a number of grains which show the range of morphologies and features typical of that mineral. Where appropriate, pleochroism and interference colours are illustrated by presenting pairs of photographs with the polarizer at different orientations. All minerals are shown in both plain polarized light and under cross-polars. The more common minerals such as zircon and apatite are given greater attention with more photographs and longer descriptions.

In some cases the text accompanying each mineral includes some general remarks and appropriate references. It is a pity that this extract information is limited to only some instances, and is always rather brief. Further information about each mineral and some guides into the specialist literature in that field would have added to the usefulness of this book. There is space in this book to provide further information: each mineral description starts on a new page, leaving numerous blank expanses of paper which add up to almost a quarter of the page area in the description section. Although this makes for very easy use of the book, it is tempting to suggest that this space could have been occupied by more information.

The first thirty pages of the book describe the principles and practice of the study of heavy minerals in sediments. Short chapters on applications and limitations, methods, presentation and analysis are clear, concise and provide adequate references. These sections are clearly only intended to provide a brief introduction to the topics, although further discussion and information would have been welcome in several instances. In particular, a couple of examples of how data may be presented and further brief case studies which illustrate the range of applications of heavy mineral analysis would have made this text more complete. In contrast to the high quality illustration of the minerals, the figures and tables in this first section are rather crude by comparison. A book which is otherwise of very high quality in terms of presentation has been spoilt by unimpressive diagrams and tables apparently typed and drawn up with a pen and ruler. An identification summary table in an appendix is