The book is well organised, with the unit operations described first, followed by a comparison of the various processing practices employed both in the UK and USA. However, the authors often digress into the processing of waste glass, plastics and rubber tyres which is rather out of place in this book. I found the poor quality type and diagrams frustrating and felt a list of abbreviations would have been helpful. Nevertheless, this book is a timely publication and the technical content admirable. The introduction is sufficiently general for novices and I am sure it will prove a useful technical manual for engineers in the chemical, metals and mineral industries wishing to know the latest technologies involved in the reprocessing of metals. J. COTTER-HOWELLS

Stoiber, R. E. and Morse, S. A. *Crystal Identification with the Polarizing Microscope*. London and New York (Chapman & Hall), 1994. Price hardback (0-412-04821-3) £65.00; paperback (01-412-04831-0) £24.95. 385 pp., 156 figs.

Of the topics with which a student of geology must become familiar in his initial training, crystal optics is probably the one which causes the most difficulty. Despite the fact that the techniques have not changed much in the last fifty years nor have the instruments used, new text-books in English on this subject are published every few years. Can this be due to dissatisfaction with the existing books and do the new authors feel that a different approach to teaching optics is required?

Stoiber and Morse in their Preface say "We offer this new book in the firm belief that crystal identification with the polarizing microscope is not only still a fundamental skill in the earth sciences but is also a tool of growing power and simplicity". The most noticeable difference between this book and others is the emphasis on refractive index determination as a means of identification of minerals. These authors inform us that 'At some institutions, immersion methods are alternated with thin section study in dual two-hour lab sessions each week". In most geology departments in the U.K. the time allocated to methods of determining refractive indices is probably not more than one or two hours in the whole course, mainly because of the necessity to teach other topics. There is probably another, more important, reason however in that, of the optical properties which students are taught, refractive indices are the most difficult to measure accurately. Most geologists. even those specializing in mineralogy and petrology, do not have a set of refractive index liquids in their offices and they are unlikely to know which of their colleagues has an Abbe-type refractometer available. Even those who may occasionally use immersion oils to study mineral grains would hesitate before attempting to measure a refractive index of even a cubic mineral and certainly not with the accuracy that Stoiber and Morse would like to achieve. To be fair, these authors tell us that an accuracy of ± 0.002 often suffices for identification purposes.

Of the immersion methods, Stoiber and Morse favour the oblique illumination method (they do not mention the name of van der Kolk) over the Becke method. One chapter is devoted entirely to the immersion method, and in the chapters on uniaxial and biaxial minerals, worksheets have been constructed for mineral identification including R. I. measurements.

The treatment of uniaxial and biaxial interference figures begins fairly conventionally and, after a discussion of estimation of the size of optic axial angle, embarks on a description of one- and two-symmetry plane figures. The one-symmetry plane figures fall into two categories of counter-rotating (C R) and same-rotating (S R) one isogyre figures. Eight pages are devoted to the appearance of the interference figure. In contrast the Universal Stage is allotted only four pages and of these only seven lines are devoted to conoscopic observation.

Forty years ago, in one Department of Geology and Mineralogy in the U.K., the Professor decreed that each first year student of geology should have access to a Universal Stage and so twelve were constructed in the departmental workshop (to purchase U-stages was prohibitively expensive). This represents another approach to teaching the student to understand the appearance of the interference figure in different orientations of the crystal. Few undergraduates, at least in the U.K., will be taught much about the rise of the U-stage nowadays but it is to be hoped that they would learn that, with the correct objective and sub-stage condenser, the conoscopic method is ideal for measurement of optic axial angle in most cases.

In the last ten or twenty years the availability of electron probe microanalysers and electron microscopes incorporating analytical facilities has resulted in a dramatic reduction in the use of quantitative optical methods of determining the nature and composition of minerals, to such an extent that few students will use more than the simplest optical techniques routinely before transferring their thin sections to a microprobe for analysis.

James Thurber, the American humorist, once defined a critic (a reviewer) as a person who "looks into a microscope and sees his own eye". I hope that this reviewer will not be accused of this offence in being critical of some aspects of this book. The following statement in the Preface came as a complete surprise "An elegant treatment of alkali

feldspars is drawn from the recent literature and analytic equations are given for determination of their composition". We are told that, since the alpha refractive index changes very little with ordering in the alkali feldspars, it is a sensitive guide to composition in intermediate or Or-rich feldspars and they suggest that the composition can be obtained to within 5 mole per cent. Thereafter, a 2V measurement gives a measure of disorder and the composition can be refined. Is this not turning the clock back a few years?

Surely most petrologists, if they are interested only in the Or/Ab ratio of an alkali feldspar, will obtain this much more easily from a powder diffraction pattern which takes only a few minutes to scan, and at the same time unmixing, which may not have been seen optically, can be detected. A careful study of the mineralogy of a feldspar-bearing rock will require a determination of the An content of the alkali feldspar and this cannot be achieved optically. If the feldspar is unmixed to the extent that this is visible under the microscope, the compositions of the separate phases will have to be obtained by microprobe. Despite fairly detailed discussion of the optics of feldspars, the terms perthite and microperthite appear nowhere in the text!

Each text book on crystal optics has its own strengths and weaknesses. This book will be a useful reference work for those mineralogists who wish to make the maximum use of refractive indices as a technique for the study of a mineral or a mineral series. A relatively recent study by Gunter and Bloss (Amer. Min. 1982) of the changes in refractive indices in the andalusite–kanonaite series is a very elegant example of the value of a careful study of refractive indices. W. S. MACKENZIE

Birch, W. D. and Henry, D. A., Eds. *Phosphate Minerals of Victoria.* Melbourne (Mineralogical Society of Victoria — Special Publication no.3), 1993, Price $(Australian) 40.00 (+ overseas postage $ 15.00 seamail; $ 26.00 airmail). ISBN 0 959 4573 2 1. viii + 182 pp., 215 figs.

This well illustrated book describes forty-eight recorded phosphate minerals in their various associations and geological environments, including granites, sediments and cave deposits. The text is illustrated with photographs (115 in colour), maps, crystal drawings and SEM photographs.

After an introductory chapter, there are comprehensive reports on the phosphates in granites and in mafic igneous rocks, including microprobe analyses of fluorapatite, cyrilovite, kidwellite, leucophosphite, eosphorite, wardite and rockbridgeite, together with locality details and mouth-watering colour photographs of libethenite, sampleite, saléeite, torbernite, turquoise, ulrichite, eosphorite and wycheproofite. Turning to the phosphates from oxidized sulphide deposits, detailed descriptions, microprobe analyses and photographs are presented for green, brown and yellow pyromorphites. Sedimentary phosphate deposits are widespread in Victoria and are hosted by Palaeozoic black slates, sandstone/siltstone, Tertiary marine strata with phosphatic nodules and terrestrial alluvial deposits. Wavellite, cacoxenite, fluellite, rockbridgeite, sasaite and turquoise are described from the black slate deposits, whereas vivianite is the dominant phosphate in the sandstone/siltstone-hosted deposits. Spectacular large blue or green vivianite crystals were also found in volcanic tuff at Wannon Falls. The detrital phosphates are mainly represented by monazite-(Ce), for which 18 analyses are given.

Guano deposits in the Skipton and Parwan cave systems contain significant suites of phosphate minerals; full descriptions are given for struvite, hannayite, newberyite, schertelite, sasaite and dittmarite from the Skipton lava cave and for montgomeryite, carbonate-hydroxyfluorapatite and gordonite from Parwan caves. Finally, a note is given of schreibersite in the Cranbourne iron meteorite and in the Murchison carbonaceous chondrite. The bibliography includes some 150 references.

This book is the third in a series published by the Mineralogical Society of Victoria, the first having dealt with minerals of the Maldon Goldfield and the second with the zeolites of Victoria. This comprehensive book on phosphates fills an important gap, as little had been previously written on phosphate minerals and their localities within Victoria, and much of the material presented represents the results of detailed research by the senior editor. The high standard of the illustrations and the very complete locality details will make this book attractive to all mineralogists. R. A. HOWIE