

syenite composition will merely cause it to freeze by crystallizing alkali feldspar. Whatever AFC modelling may suggest, phase equilibria cannot be ignored. McHone introduces plumes to the volume, concluding that the Mesozoic alkaline intrusions on land in N.E. North America are not a straightforward extension of the chain of New England seamounts in the Atlantic basin and cannot be explained by the straightforward over-riding of a stationary mantle plume. McLemore *et al.* introduce economic aspects of alkaline rocks, in the context of the Wind Mountain laccolith, New Mexico, and Miller continues the economic interest, describing rare-element peralkaline granite pegmatites from Strange Lake, Labrador.

The next three papers are about carbonatites, the first, by Barker, discussing the premise that carbonatites may not necessarily represent 'juvenile' mantle carbon but carbon recycled deep into the mantle by subduction. This enjoyable and clearly written review deals with the now widely accepted role of deep carbonate liquids as the main carrier of the elements in which mantle rocks need to be metasomatically 'enriched' prior to extraction of alkaline magmas, and can be recommended for student use. It is followed by an account of extrusive carbonatite from the Eifel (Riley *et al.*) and then by an account of carbonatites from Kola by Bulatch and Ivanikov.

The final group of six papers has a mineralogical emphasis. Simonetti *et al.* describe beautifully zoned diopside phenocrysts in nephelinites from Napak, Uganda, and Woolley *et al.* describe unusually aluminous alkali pyroxenes from Malawi, produced by metamorphism of agpaitic rocks. Currie and Van Breemen discuss the origin of rare minerals in the Kipawa syenitic complex, Quebec, Zaitsev describes carbonate minerals from carbonatites in the Khibina Massif, and McCormick and Le Bas describe phlogopite in carbonates from Uganda. The final paper, by Chakhmouradian, describes niobium and rare-earth minerals in carbonatite from Oka, Quebec.

This is a useful volume with a number of high quality papers. The standard of editing is high, without errors, but I would have found a table of contents useful. However, in contrast with its predecessors of ten and twenty years ago most contributions do not have a review character. It would have enhanced the collection had the authors provided an overview of what the big ideas of the present are, and where they are taking us. A reader ten years in the future will not find it easy to single out the important advances of the last ten years from this volume, however useful the individual papers to *aficionados* of alkaline rocks. I. PARSONS

Grew, E.S. and Anovitz, L.M. (Eds). *Boron Mineralogy, Petrology and Geochemistry*. Reviews in Mineralogy 33, Mineralogical Society of America. xx + 862pp. Price \$32.00 (\$24.00 to MSA members). ISBN 0-939950-41-3.

When dealing with boron, one's thoughts automatically turn to tourmaline and a short chapter in the DHZ student volume, little suspecting that it is possible to come across a book with 862 pages devoted to this element and its mineral hosts. This book is encyclopaedic in its coverage, with nineteen contributions from thirty one authors. It is all the more remarkable that the book contains over 140 pages of references, although many overlap as they are given chapter by chapter.

After an explanation of why its cover is graced with a particular shade of green, the book starts with what amounts to an apology: Anovitz and Grew introduce the topic of boron mineralogy, petrology and geochemistry and emphasise how little is known. They list boron minerals in a table which occupies over 20 pages, summarizing details of each occurrence and giving key references. Hawthorne and Burns get to grips with the crystal chemistry of boron, and introduce the nomenclature used to describe the multitude of possible structures. It is reassuring to discover that there is a hierarchical approach to dealing with what at first appears to be a chaotic problem.

Werdning and Schreyer devote a chapter to the synthesis of boron minerals, focusing on the high pressure borosilicates, followed by Navrotsky's very succinct summary of the thermochemistry of borosilicate melts and glasses (including discussion of commercial glasses such as Pyrex). Both chapters identify questions which need to be addressed in future work. A detailed and critical review of the available thermodynamic data is provided by Anovitz and Hemingway, who give data where available for the essential thermodynamic quantities.

Moving on to occurrences of boron, a geological framework is adopted. First, continental borates are considered (Smith and Medrano), looking at borate deposits largely from the point of view of the economic geologist. This chapter focuses on those associated with evaporites, and associated diagenetic reactions (addressing borate mineral stabilities as a function of pore fluid composition and temperature). A useful table of literature sources is provided. London, Morgan and Wolf move to the other extreme of crustal environments, looking at boron in granitic rocks and its behaviour within natural magmatic systems. How boron enters a melt, and what controls

the stability of tourmaline, are both considered in detail, with reference to experimental products as well as natural systems. Dingwell, Pichavant and Holtz review experimental data concerning the behaviour of boron within granitic melts, providing information about its influence on the physical properties (such as viscosity and density) and chemical properties of granitic melts, mostly from studies of synthetic systems.

Two very substantial reviews follow. Grew reviews the occurrence of around 15 borosilicates (excluding tourmaline) in metamorphic environments. He gives optical properties, chemical analyses and details of occurrences, including associated mineral assemblages. Estimates for the stability limits ($P-T$) for kornerupine, dumortierite and grandierite are given, together with consideration of the extent and impact of B substitution in other silicates. Henry and Dutrow provide a long chapter on tourmaline in metamorphic environments, detailing the common tourmaline species and their solid solutions, and giving substantial compositional data (including trace elements). Sources of data are well tabulated.

Slack's chapter on tourmaline in hydrothermal environments starts with the field description of typical associations which may be varied in type (as in granites), veins as in volcanic and metamorphic rocks, stratabound or as tourmalinites. Key major element compositional data are presented, together with isotope data.

Moving on to more general geochemical topics, Leeman and Sisson review the geochemistry of boron and how that impinges on crustal and magmatic processes. This chapter includes a summary of data for B in standard rock reference materials, and looks at the global distribution and fluxes of boron. There is a brief overview of the analytical methods used to determine boron in rocks. Palmer and Swihart discuss boron isotope geochemistry, from fractionation through to examples of occurrences for which data are available, and their interpretation. Both chapters bear on cosmochemistry, and provide an introduction to Shaw's comparison of the behaviour of boron in lunar and terrestrial systems. The absence of water on the Moon has most influence; there, boron behaves entirely as an incompatible element, in marked contrast to its behaviour on Earth.

The book finishes with five chapters on instrumental methods of investigating boron in geological materials. McGee and Anovitz focus on electron microprobe methods, working on the basis that any probe worth its salt (nowadays) will be able to determine boron directly. The chapter provides

valuable insights into the problems which are specific to the determination of boron. Hervig provides an account of use of the ion probe, comparing the use of different instruments around the world, with good tabulation of data sources. Nuclear methods (particle induced gamma emission, prompt gamma neutron activation, fast neutron activation) are described in detail by Robertson and Dyar, and EELS methods are described by Garvie and Buseck. Finally, application of mass spectrometry in the investigation of boron is reviewed by Swihart.

As far as production is concerned, the book suffers from poor printing quality, with blurring of the type face in some places, and an abundance of fine print which is not easy to read. A missing figure is supplied for a scissors and paste insertion into the right place.

This is, overall, a book with something for everyone with an interest in boron and its minerals. Those interested in boron deposits associated with volcanic rocks, such as the Turkish calcium borate mineral deposits, might well be disappointed, and there is no special attention paid to the aqueous geochemistry of boron. The editors are well aware of the book's limitations, and it could well have become unmanageably large. As it is, it is difficult to take in all that the book has to offer without settling down to use it, with students, over a period of time. I have no doubt that this will be one of the most useful Reviews in Mineralogy; it is unlikely that any attempt will be made to provide such an extensive summary of the geochemistry, mineralogy and petrology of boron for many years to come.

D.A.C. MANNING

Deer, W.A., Howie, R.A. and Zussman, J. *Rock-Forming Minerals*, Vol. 2B, *Double-Chain Silicates* (2nd Edition). London (The Geological Society). 1997, xii + 764 pp. Price £99 (US\$165), Geol. Soc. and Min. Soc. members £50 (US\$83). ISBN 1-897799-77-2.

Here is the long awaited DHZ volume 2B on amphiboles, 764 pages packed with information, 400 figures over 500 chemical analyses of amphiboles, nearly 3000 references — the calcic amphiboles alone have 63 closely packed pages of references, amounting to almost 1700 items — indeed a summary of almost everything known about amphiboles up to 1996, and at a bargain price.

The format follows that now well established: an opening page for each mineral group with a summarized chemical formula, the optical and physical properties, the space group and cell size