crustal structure, while Soper and Moseley describe the tectonic fabric of the area. This last chapter is worthy of special mention since it provides the first comprehensive review of this complex subject and largely resolves the controversy over the timing of the main phases of deformation in the Lake District.

Not surprisingly the largest part of the book is concerned with stratigraphy and includes chapters on all the systems represented in the area. This section begins with a review, by Wadge, of the Lower Ordovician stratigraphy—a subject which has undergone considerable revision over the last few years. The following chapters cover the Skiddaw Group (Jackson), Eycott and Borrowdale volcanic rocks (Millward, Moseley, and Soper), Upper Ordovician and Silurian (Ingham, McNamara, and Rickards), Devonian (Wadge), Carboniferous (Mitchell, Taylor, and Ramsbottom), Permian and Triassic (Arthuton, Burgess, and Holliday), and the Quaternary (Pennington). In all cases these chapters are up to date (1978) and provide a thorough review and modern interpretation of the sequence of strata observed in the area.

Igneous intrusions are dealt with by Firman in a chapter inserted between the Silurian and Devonian chapters (a chronologically appropriate slot for many of the Lake District intrusions). Rb–Sr ages of the more important intrusions were published by Rundle (*J. geol. Soc. Lond.* **136,** 1979, pp. 29–38) too late, unfortunately, to be incorporated fully into this book though Firman added a brief note after the book had gone to press summarizing Rundle's conclusions.

The mineral deposits of the Lake District have been exploited intermittently over the past 800 years or more and mining continues today with the extraction of tungsten from the Carrock Mine and hematite from western Cumbria. The history of this mining, the distribution and genesis of the mineral veins and the potential for future exploitation are reviewed by Firman in Chapter 15.

The remaining three chapters cover aspects of geology usually given only a brief mention or ignored altogether in regional geology texts. These are off-shore geology (Fletcher and Ransome), hydrogeology, and environmental geology (both by C. K. Patrick). All three subjects are of growing public interest and so their inclusion in this book is most welcome.

In conclusion, this is a comprehensive text which will stand for many years as the authoritative work on Lake District geology. My only reservation about the book lies in the adoption of the term 'Eycott Group' (Plate 1 and Chapter 6) to include both the volcanic rocks of the type area and sedimentary rocks of the same age occurring elsewhere in the Lake District. Over the years the word 'Eycott' has become inextricably associated with volcanic rocks and so the usage proposed here, though stratigraphically correct, is certain to lead to confusion.

The book has been very well produced, is beautifully illustrated and has been published at a very reasonable price. It is an invaluable source of reference for research workers in many fields and is essential reading for anyone, professional or amateur, with an interest in this fascinating part of Britain.

J. G. FITTON

Sand (L. B.) and Mumpton (F. A.), Editors. *Natural zeolites occurrence, properties, use.* Oxford (Pergamon Press), 1978. xii + 546 pp., 429 figs., 158 tables. Price $82·50.

Since the discovery of thick altered tuff beds consisting almost entirely of zeolites in many parts of the world in the late 1950s, the status of this mineral group has changed from being little more than a 'museum curiosity' to that of an important commodity for which, as Professor Mumpton describes in the introduction to this selection of papers presented at Zeolite '76 (Tucson, Arizona), new applications are being found almost on a monthly basis. Research on the dehydration, adsorption and ion-exchange properties of chabazite and mordenite between 1930 and 1950 established that the zeolite group had a wide range of potential applications. At that time, however, it was assumed that zeolites only occurred in cavities in basaltic rocks and, as there was no way in which they could be extracted in amounts large enough to support a commercial operation, synthesis seemed to be the only answer. Considerable commercial investment was directed to the development of synthesis processes and by the time the large natural zeolite deposits were recognized, a vast body of knowledge existed on the structure and properties of synthetic zeolites. From then on, again quoting Mumpton, 'there is no doubt that the side-by-side efforts of the chemists and geologists have had a synergistic effect on the overall development of natural zeolite technology'.

The forty-five papers in this book are almost equally divided between zeolite mineralogy/geology and technology. The first section, 'Crystal Structure and Mineralogy', contains a general survey of zeolite structural chemistry by Gottardi, followed by detailed structural chemical studies of chabazite, ptilolite, offretite-levynite, barrerite, mordenite, and dachiardite. An article by Mumpton and Sand on the morphology of zeolites

in sedimentary rocks by SEM, originally published in *Clays Clay Mineral.*, **24** (1976), 1–23, is also reproduced.

The second section, on 'Geology and Occurrences', again opens with an introductory paper by Hay and contains separate surveys of zeolite occurrences in alkaline lake deposits, marine environments and geothermal zones. Five papers are devoted to studies of marine phillipsite, clinoptilolite, and laumontite and three to the experimental alteration of glass or ash to zeolites.

The third section on 'Physical and Chemical Properties' is introduced by Vaughan and contains a brief survey of cation exchange equilibria in zeolites and feldspathoids by Barrer, five papers on sorption, diffusion, and catalytic properties of various zeolites, and one on the thermal stability of gmelenite. Applications are described in the fourth section, emphasis being placed on use as ion-exchangers in water purification and pollution (both radioactive isotope and heavy metal) control, and other topical areas such as energy saving—Tchernev describing how chabazite and clinoptilolite can be used as solid adsorbers in heat exchangers of solar panels. One of the first countries to exploit natural zeolites was Japan, and the numerous uses in the country are summarized by Torii (due to Japan's deficiency in kaolinite, zeolites are used for paper-filling, this application accounting for at least 50% of the country's output). An interesting description of the beneficiation of low-grade zeolite beds at Bowie, Arizona, completes the book. Author and subject indexes are provided.

Abstracts of all the papers are given in M.A. 80—1209. Apart from being essential reading for workers in the zeolite field, the book should be of more than passing interest to sedimentologists and marine geochemists in view of its extensive coverage of sea-floor sedimentation and diagenesis. Every Departmental and Institutional Library should have a copy of what will become, if it isn't already, a standard reference work but it is unlikely to find its way into individual collections (apart from those of book reviewers) because of the price.

D. J. MORGAN

Pies (W.) and Weiss (A.). *Crystal Structure Data of Inorganic Compounds. Part c3: Key Element C.* (Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology, New Series. *Group III. Crystal and Solid State Physics. Vol. 7*). Berlin, Heidelberg, and New York (Springer-Verlag), 1979. xxvii+291 pp. Price DM 360 ($201.60). Part b2: Key Elements O, S, Se, Te. 1980. xxv+210 pp. Price DM 265 ($148.40).

Two further volumes in this series have now been published (see *Mineral. Mag.* **43**, 187, 563, 832). Volume c3 completes the subset of crystal structure data on inorganic compounds with the key elements N, P, As, Sb, Bi, C as the anion or part of the anionic group. Under the key element C one therefore finds graphite intercalation compounds (but not graphite or diamond themselves), carbides, carbonyls, carbonates, cyanides, cyanates, etc. The extensive section on carbonates is likely to be of most use to the mineralogist and, when the series is fully indexed, will provide the reader with access to sources of much structural data.

Part b embraces the key elements O, S, Se, Te and this subvolume (b2) is restricted to the oxyfluorides, oxychlorides, hydroxide chlorides, chlorates, bromates, iodates, and other oxyhalogen compounds. A number of minerals of current research interest, such as boleite and blixite, occur among the hydroxide chlorides.

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