

detergents, where they replace previously used water-softening agents such as polyphosphates which have been shown to damage the environment. In contrast, natural zeolites are still generally only used in low-value bulk applications such as soil conditioning or as constructional raw materials, despite their similar properties and the common occurrence of near-surface volcano-sedimentary deposits of relatively high grade. In one of the key papers in these proceedings of an international conference held in Budapest in 1985, Dr Fred Mumpton argues that this situation has arisen through poor marketing techniques that have attempted to sell the natural products for sophisticated applications without the necessary background research to match the specific zeolite with the intended use. He must therefore have been encouraged by the volume of such information provided by his fellow contributors to this book. Of the 66 papers included (abstracts of all these in *Mineralogical Abstracts* 89M/3037–3102), about half provide use-related data obtained either in the laboratory or from pilot-plant or field trials.

A group of six papers deals with the removal of ammonia, phosphate, heavy metals and organo-chlorine compounds from drinking water and industrial waste effluents—practical examples of ion-exchange that make a welcome change from the still-common studies in the literature which present exchange isotherms for a range of cations on yet another natural zeolite (although it should be noted that there are a few such papers in this volume!); three papers also discuss ion-exchange properties of natural zeolites in relation to radioactive waste disposal. Other equally useful groups of papers describe applications of adsorption properties (removal of organo-sulphur compounds from oil, oxygen enrichment of air, and heat-exchange due to the adsorption-desorption cycle of water molecules) and catalytic properties (mainly for dehydration and cracking of hydrocarbons). Only one paper is concerned with the use of zeolites for soil conditioning but there are four describing the beneficial effects of zeolite addition to livestock feeds. There is no doubt that this works—in the sense of increasing meat yields—but as G. V. Tsitsishvili describes in one of three papers taking overviews on applications, the mechanism is complicated and involves interplay of a number of zeolite properties with the metabolic processes of the animal.

The other papers in these proceedings cover zeolite geology, mineralogy and crystal chemistry. As with those dealing with applications, there is a strong bias towards contributions from Eastern Europe, and the book is thus useful for drawing

attention both to the quantity and quality of zeolite research being carried out there. The book itself is well-produced from uniformly typed camera-ready copy and there is an adequate index; the only disappointing feature is the quality of the half-tones which are no better than photocopies. It will be a valuable addition to the small number of texts dealing specifically with natural zeolites.

D. J. MORGAN

Skinner, H. C. W., Ross, M. and Frondel, C. *Asbestos and other Fibrous Minerals*. New York and Oxford (Oxford University Press), 1988, iii + 204 pp. Price £26.00.

Asbestos, it seems, is a continuing subject of interest. Several publications in recent years have presented the theme from differing aspects, and this book finds yet another one, although the content is familiar.

The background is the Occupational Safety and Hygiene Administration (USA) definition of respirable asbestos fibres, stating that they should be greater than 5  $\mu\text{m}$  in length and have an aspect ratio of at least 3:1. This definition, and its parallel in the UK, has raised a controversy because it can apply to a great number of minerals which are not asbestiform, including a few which are already known to bring about biological effects in man.

The authors start by asking what is a fibre, and consider the meanings of the words asbestiform, fibrous, acicular and fibrillar. The general properties of fibres, both structural and physical, are explored in an attempt to ascertain their distinctions. Chapter 2 deals with the structures and crystal chemistry of naturally occurring minerals which may be found in fibrous or acicular form, including asbestos, micas, talc, clay minerals, vermiculite, zeolites, silicas and a number of non-silicate minerals. Synthetic fibres such as those of glass and carbon are also covered. Most of this is familiar mineralogical data, but it is put together with excellent structural diagrams and a clear and informative text which emphasises chain structures and fibrous habits. Specifically the work of Wicks, Whittaker, and Zussman on the serpentines and chrysotile, and that of Veblen and Buseck on microstructures in the amphiboles is well summarized. Erionite, the zeolite strongly implicated in pleural diseases in the Karain area of Turkey, is given a few worthy paragraphs, which illustrate, if anything, its acicular nature. An appendix to the book records 388 mineral species, mainly from Dana's System of Mineralogy,

7th Edition, which may at least occasionally occur as fibres; and a further appendix lists over 200 types of synthetic inorganic fibres and whiskers.

The third and final chapter on health effects arising from fibre inhalation covers the characterization and etiology of asbestosis, pleural diseases and mesothelioma, and lung cancers. The human respiratory and lymphatic systems are described in detail and are shown in a number of clear diagrams. Much of the experimental approach since 1965 to our understanding of the biological effects of asbestos is covered, although the references appear to cut short at 1980, leaving out some important work since that date. The epidemiology of asbestosis and other fibre-related diseases is well summarized up to 1985, particularly with regard to exposure levels and the debate on a safe threshold level.

Bearing in mind its theme, this is a useful, well written and well presented book which should be of wide interest to the producers and users of industrial minerals, to those involved in environmental mineralogy, and the medical researchers who wish to know more about potentially hazardous mineral particles. For those non-medical readers who may be drawn into dialogues (sometimes litigative) on the biological effects of respirable fibres this compact publication is worthy of a place on the bookshelf for its final chapter alone.

The book has a few typographical errors, but an unfortunate one in Table 1–2, page 14, shows fibre tensile strengths in terms of  $\text{kg/cm}^2 \times 10^{-3}$  instead of  $\text{kg/cm}^2 \times 10^3$ .

A. A. HODGSON

Halbach, P., Friedrich G. and von Stackelberg, U. *The Manganese Nodule Belt of the Pacific Ocean*. Stuttgart (Ferdinand Enke Verlag), 1988. x + 254 pp., 190 figs. Price DM186.00.

This book is largely, but not entirely, an overview of German efforts in manganese nodule studies in the NE Pacific ore-grade nodule belt (Clarion–Clipperton zone) in the 1970s and very early 80s. As such, much of the material in it has already been presented in more detail in the scientific literature, but this book brings it together in an easily accessible and readable format.

The book starts with a vigorous promotion of the nodules as a future mineral resource. Doubters of the viability of future nodule mining should read this. Chapters 3 and 4, with one exception, largely deal with nodule nature and distribution, and present a useful overview of these subjects. The exception is a detailed paper on the structural chemistry of manganese and iron

minerals and synthetic model compounds, which represents a significant advance on previous papers on this topic. Had this paper been published when written, it would have significantly influenced several subsequent studies and its delay in publication is to be regretted.

Chapter 5 concerns the environment of formation of manganese nodules and goes well beyond the confines of the C.C. zone in its scope. It represents an excellent synthesis of mostly sediment studies related to nodule development and as such is essential reading for all serious students of 'noduleology'.

Chapter 6 concerns the growth processes involved in the formation of nodules, and presents a useful overview. There is a certain amount of repetition of material presented in previous chapters, but this is perhaps inevitable in a volume with so many authors.

The remaining chapters present a concise summary of some of the exploration, mining, processing, assessment, legal and environmental considerations relating to future nodule exploitation. Much of this is fairly straightforward, but the legal chapter is somewhat dated, as events have moved on since it was written.

Dealing as it mainly does with the C.C. zone, this book largely ignores work on nodules done elsewhere in the Oceans. Even its title is something of a misnomer, as there is not one but several manganese nodule belts in the Pacific ocean. There is little mention of the Japanese work on nodules in the Central Pacific Basin, nor of nodule studies in the EEZs of the South Pacific island countries which has been the subject of much attention in the past few years. Likewise, there is no mention of the nodules of the Central Indian Ocean, similar in many respects to the C.C. zone nodules, on which work was commenced independently by British and German workers in the 1970s and has since been ably taken up by Indian workers. Nevertheless, in spite of these limitations, this book represents an excellent synthesis of a very important body of knowledge on nodules.

D. S. CRONAN

Jones, M. J. (ed.) *Silver—Exploration, Mining and Treatment*. London (Institution of Mining and Metallurgy), 1988. 344 pp. Price £40.00.

The recent spate of intense exploration for, and development of, gold deposits has resulted in a large number of publications related to gold. By contrast, silver deposits have remained relatively neglected. It is thus of interest to see a publication