

## BOOK REVIEWS

Barrer, R. M. *Hydrothermal Chemistry of Zeolites*. London and New York (Academic Press), 1982. x + 360 pp., 107 figs. Price £31.00.

This book is the second of a series which the author has been preparing on different aspects of the chemistry of zeolites and related minerals. It is a detailed and systematic study of the hydrothermal syntheses of these materials, and of the chemistry of their modification subsequent to synthesis. There has not been to date a book which deals exclusively with this complicated topic, and this monograph is therefore welcome, especially as it is written by one who is universally recognized for his extensive pioneering and development work in this area.

The first chapter is a general introduction to the subject, opening with a description of the modes in which zeolite minerals occur naturally. This is followed by discussions first on their structural classification and then secondly on the characteristic properties which make them important from a technological viewpoint as molecular sieves, catalysts, and ion exchangers. Chapter Two follows this with a survey of the hydrothermal chemistry of silicates in general rather than just zeolites, thus laying down some general principles. Although this chapter alone cites 180 references, it is much more than just a catalogue or literature survey, in that the subject is developed and rationalized in terms of basic theoretical concepts. Thus there is a section on the thermodynamics of multi-component phase equilibria, and following this the stabilization of porous crystals by guest molecules is also discussed from the thermodynamic viewpoint. Next covered are the properties of water in melts and the converse subject of the effect of the differing solubilities of substances in water on synthesis conditions, illustrated using phase diagrams. After a brief discussion on the effects of alkalinity, the chapter closes with a survey of examples, covering clays, hydrothermal micas, crystalline forms of silica, feldspars, and feldspathoids.

The practice of inter-weaving basic theoretical concepts with practical examples is carried on through the next three chapters, which develop in a logical progression the subject of zeolite synthesis in particular. Chapter Three is concerned with the nature of reactants and the structure of the polynuclear anions which are believed to be found in solution prior to the nucleation stage. Techniques which are employed in studying these species are also discussed, including the use of high-resolution  $^{29}\text{Si}$  nmr spectroscopy. Chapter Four extends the discussion to the stages of nucleation and crystal

growth, with sections which describe the kinetics of these processes. The nature and rates of growth on seed crystals are also covered, as are the effects on crystallization growth rates of temperature, alkalinity, organic bases, and the structuring and templating properties of cations. Other matters covered are history-dependent factors, the effects of dye-stuff additives, metastability, zoning, and the growth of larger crystals.

Having discussed in the previous chapters the principles and variables which are important in the hydrothermal synthesis of zeolites, Chapter Five develops this by using numerous representative examples. The subject is illustrated extensively with crystalline field diagrams, which delineate the regions of composition, temperature, and pressure within which a particular product or set of products may be found. The chapter is divided into sections which deal first with direct synthesis from aluminosilicate gels at high or low temperatures, then secondly with transformation reactions involving layer silicates, glasses or other zeolites.

Modification of the composition of zeolites by isomorphous replacements within the lattice framework is an aspect of zeolite chemistry which has attracted much interest recently, since these modifications can lead to marked changes in catalytic and sorptive properties, as in the hydrophobic high-silica zeolites. Chapter Six is concerned with this subject, especially replacement of aluminium by silicon. Preparation of isomorphous zeolites having different Si:Al ratios, and methods of modification subsequent to synthesis are both discussed. The subject is considered from a statistical thermodynamic viewpoint, and studies on Si:Al ordering in zeolites using techniques such as magic-angle spinning nmr are also covered in depth. Substitution of other atoms, including Ga, Ge, B, Be, N, and P are also considered. The book concludes with a chapter on isomorphous replacement by salts of water within the crystals, and the consequent effects on the properties of the minerals. It is probably true to say that this is an area of zeolite chemistry which has received less attention in recent years, although the author points out the considerable practical potential of these materials.

Although the book has been clearly written with the synthetic or industrial chemist primarily in mind, it is likely also to be near-indispensable to the mineralogist who is interested in the hydrothermal genesis of these materials in basalts or sediments. The literature coverage is very comprehensive, and extends to papers which were only just appearing at

the time the book was published, an important requirement in a subject which is developing as fast as this one. Thus the recent controversy concerning the validity of 'Loewenstein's rule' and zeolite A in particular is covered. Also the very recent studies on a novel series of aluminophosphates are considered, and the development and synthesis to date of the high-silica ZSM and Nu zeolites are documented and discussed.

The book is well produced, with text and diagrams clearly printed on good-quality paper. The quality of production is reflected in the price; nevertheless it is well worth purchasing and thoroughly recommended.

R. P. TOWNSEND

Wilson, A. N. *Diamonds: from Birth to Eternity*. Santa Monica (GIA) 1982. xxv + 450 pp., 88 figs., 30 colour plates. Price US \$43.95.

This is a compendium of the most recent information and opinions on the origin and distribution of diamonds. It is written for the general reader in a free, open, and personal style, and is tastefully illustrated by sketches, diagrams, tables, and colour plates. Throughout the book the author translates and assesses highly technical information in a form readily understandable by the non-specialist. The procedure adopted is to describe in Part I the geological background to diamonds and kimberlites, incorporating the latest ideas on plate tectonics, ocean-floor spreading and age determination. In Part II a more detailed description of diamond distribution is followed by an extremely useful tabulation of the actual occurrences of diamond in kimberlite or gravels, and of kimberlites both diamondiferous and barren. In the table, the occurrences are given in chronological order starting with the oldest known diamonds in the Witwatersrand; each is assigned a stratigraphic or an isotopic age and a reference is given to later text where more fascinating detail can be found. This part forms the major section of the book (278 pages) and is a wealth of information about the historical, technical, and in some cases the social background to the discovery and development of particular deposits. The book has been designed with wide margins beside the text and these are commonly used in a well-spaced, uncrowded way for black and white sketches of the principal characters or places mentioned in adjacent text. However, the abundance of information and ancillary description has its price in that particular details you may require to refresh your memory can be difficult to locate. Part III is an eighteen-page exploration of the idea that kimberlites are fundamentally related to major rifts in the Earth's crust. The kimberlites are placed

in time slots and the evidence for periodicity and repeat activity outlined and assessed. In the following Part, the 'Magic of Kimberlite' explains the nature of kimberlite and the kinds of xenoliths and xenocrysts it contains. Quite rightly the difficulty of defining kimberlite is stressed and the modern ideas on formation of kimberlitic liquids discussed in suitably speculative terms. In Part V, 'Genesis', early theories of the formation of diamond are followed by the listing and classification of inclusions found in diamond. The different states of carbon are discussed and linked with the information obtained from inclusions to postulate and assess possible melting processes deep in the Earth's crust. The final sections are concerned with whether or not diamond crystallized from kimberlite.

Mr Wilson translates in a dramatic and stimulating way the many technical aspects that have been applied to the problem of diamond genesis, and although some readers may feel that one or two phrases are too colourful or too banal, in general the message comes across very well. His enthusiasm for the drama of the subject are reflected in his use of such words as magic, masterpiece, miracle, and astonishing, and these are complemented by the choice and production of some stunning colour plates. Many of the plates are full page (about 250 × 200 mm) pictures of single crystals in generally subdued and unusual colours but which are full of atmosphere and distinction. The other colour plates, again superbly produced, are directly relevant to the adjacent text as are the black and white sketches, diagrams and tables, although this reviewer feels that perhaps even further use of diagrams could have been made (especially in Parts IV and V) to illustrate the interaction of geotherms, solidii, and phase boundaries. The geoscientist and perhaps other specialists will still want to consult books such as 'Diamonds' by Bruton, and 'Kimberlites and their Xenoliths' by Dawson for more wide-ranging information on diamond or for more technical information on kimberlites, but this book updates Chapter 16 in 'Diamonds' and provides more background information to diamonds than Professor Dawson's book. There is an adequate index and there are very few anomalies, although 'plastic' in the mantle (p. 411) may raise a smile and may be inadvertently close to the truth, 'kyantie in aluminium silicate' (p. 416) is rectified in repeat information on p. 436, lamproites contain 'felsparoid' (p. 437), the Hope diamond is perhaps not at its best on a blue background, and some of the tinting in the chronological table of kimberlites is not consistent (cf. pp. 127 and 312). A small bibliography listing ten to twenty major books or research papers would have been desirable but