

BOOK REVIEWS

Borchardt-Ott, W. *Crystallography*, Springer Verlag, Heidelberg (translated by R. O. Gould), 1993. x + 303 pp., £17.50. ISBN 3-540-56679-1 and 3-387-56679-1.

There was a time when British students majoring in geology were given a grounding in crystallography. Although demanding, this gave them not only an understanding of the crystalline state — and we inhabit a dominantly crystalline planet — but it also developed the ability to think in three dimensions, an essential skill for the geologist. In recent years crystallography has been squeezed from many Earth Science courses in Britain as the growth of knowledge and perhaps the fragmentation of degree courses into modules has forced organisers to be selective. The price that is paid for leaving crystallography to the materials scientist and the physicist is that rather too many recent Earth Science graduates seem to have little knowledge of the crystalline state and of the ways in which the atomic arrangement of materials is fundamental to understanding their behaviour and of how they interact with radiation of different kinds.

It is good, therefore, to see on the market a book such as this and to know that the teaching of these fundamentals is not being entirely neglected, for it is based on a lecture course given to chemists and other students in the University of Münster for 20 years.

The book treats the subject in a logical and rigorous manner. A brief opening consideration of the crystalline state is followed by a chapter on the lattice and its properties, showing the derivation and applications of Miller indices and the zonal equation. The progression from lattice to crystal is made by considering the consequences of introducing atoms, ions, and molecules to replace the lattice points.

Chapters 4 and 5 are devoted to crystal morphology and its representation as stereographic projections, and to the principles of symmetry. This is followed by the rigorous derivation of the 14 Bravais lattices and the symmetry of Primitive and Centred lattices. The assignation of the Bravais lattices to the seven crystal systems forms the topic of a brief chapter.

Chapter 8, by contrast, devotes 65 pages to the 32 point groups. Their derivation is clearly explained,

and the International (Hermann–Mauguin) Symbols and the Schönflies notation are described and their inter-relationship discussed. This leads to a consideration of crystal symmetry and crystal forms. The ways in which general, special, and limiting forms are related to symmetry elements of point groups are explained and defined, and the forms present in each of the 32 point groups are tabulated. A further tabulation of the crystal systems, their point groups (giving both Schönflies and International Symbols), symmetry elements, symmetry-dependent physical properties, and Laue groups, is particularly valuable.

The 'meat' of the book continues in Chapter 9 which deals with space groups, extending the concept of symmetry from the lattice to the actual crystal structure. Glide planes and screw axes are discussed and the derivation of the 230 space groups from Bravais lattices is explained. The properties of space groups are next considered and the information given in the *International Tables for Crystallography* is explained. A demonstration is given, for rutile, of the way in which this information can be used to construct a crystal structure diagram.

Chapter 10 is a brief consideration of the relationships between point groups and space groups, and Chapter 11 reviews the fundamentals of crystal chemistry from the standpoint that crystal structures can be considered as spheres packed so as to fill space most efficiently and achieve the highest possible symmetry and coordination.

These principles are illustrated by reference to metals, noble gases, ionic and covalent structures, isotopes, solid solutions, isomorphs and polymorphs.

The investigation of crystals by X-ray diffraction follows in the next chapter. The Debye-Scherrer method is explained and an example is given of the indexing of a powder photograph of tungsten, together with an explanation of its JCPDS index 'card'. The concept of the reciprocal lattice is explained and the Ewald construction and the Buerger precision method are presented. The final chapter is a brief consideration of real as opposed to ideal crystals. Point, line and plane defects and their effects on crystals are discussed.

An appendix lists crystallographic symbols in common use, tabulates both planar and axial symmetry elements, and gives formulae for the

calculation of interatomic distances (bond lengths) and bond angles for each of the crystal systems. There is also a tabulation of crystal forms grouped according to crystal system.

Each chapter concludes with a set of carefully prepared exercises, and the book has also a list of selected references and a subject index. The text contains few errors: even the slip in defining the Ångstrom unit as 10^8 cm (p. 22) is unlikely to mislead for there follows its equivalent as 0.1 nm.

This text will be of value to those taking up crystallography: studied with care, it will give a sound basic understanding of the crystalline state. The author and the translator are to be congratulated in producing a clear and rigorous account that carefully explains the subject. The book is easy to read and well illustrated with over 200 clear, well labelled figures. It deserves to be widely used and, at £17.50 for the plexicover edition, it is good value.

A. C. BISHOP

Hall, C. *Gem Stones* London, New York and Stuttgart (Dorling Kindersley), 1994. 160 pp. Price £10.99. ISBN 0-7513-1026-3.

This volume in the 'Eyewitness Handbook' series offers a visual guide to more than 130 varieties of gemstones. It is abundantly illustrated with colour photographs of both cut and rough stones, typically with six or seven photographs per page, together with thumbnail sketches of the appropriate cuts used for each species. A line at the top of each entry gives the crystal system, the chemical composition (in words) and hardness, while, at the foot, the specific gravity, range of refractive indices, birefringence and lustre are listed, leaving the rest of the space clear for a description of the gemstone and its occurrence, together with the illustrations.

Ahead of the descriptive sections, there is a comprehensive introduction including sections on what comprises a gemstone, how they are formed, where they are found, and detailed sections on their physical properties (hardness, cleavage, specific gravity, lustre, morphology, refringence and birefringence, pleochroism, iridescence, chatoyancy and natural inclusions). Brief details are also given on faceting, polishing and engraving, and there are sections on the history and folklore of gems, on their synthesis, imitation and enhancement.

All these sections are again fully illustrated (and we gain a clue as to the authoritative nature of the information provided when an eminent gemmologist is seen using a refractometer and viewing stones with a hand-spectroscope); indeed Dr Roger Harding is named as Editorial Consultant and the author herself is a member of the curatorial team at the Natural

History Museum. Thus this is not only a handbook with copious and well-chosen colour photographs of high-quality gemstones, but it also gives accurate and up-to-date information on the gem species displayed. Almost the only quibble I have is with the massive green or pink Transvaal jade being described as grossular rather than hydrogrossular, which it is, — and with the neither euphonious nor grammatically correct description of pearls, jet, coral, ivory and amber as 'organics'.

But this is a wonderful text, beautifully illustrated with excellent colour photographs, and is surely a bargain at the price. It should be in the hands of all interested in this generally colourful aspect of applied mineralogy.

R. A. HOWIE

Bevins, R. E. *A Mineralogy of Wales*. Cardiff (National Museum of Wales: Geological Series No.16), 1994. 146 pp., 10 maps, 97 photos. Price £25.00 (£27.50 by post). ISBN 0 7200 0403 9.

Wales has provided ten new mineral species and, of the first reports of minerals in the British Isles, sixty-seven have been from Wales. No further justification is needed for this latest in a series of well-illustrated books on the mineralogy of popular mineralized areas.

After an introductory chapter outlining the geology of Wales and the background to Welsh mineral occurrences, with maps of mineralized regions, the main section of the book consists of an alphabetical listing of the minerals — from acanthite to zoisite — illustrated by a series of photographs, most of them in colour and of an exceptionally high quality, including a few of thin-sections or taken in reflected light. There are spectacular photographs and accompanying details for some of the species for which Wales is famous: anglesite from Anglesey, lustrous crystals of brookite from both Clwyd and Gwynedd, acicular millerite from ironstone nodules in the South Wales Coalfield, and both twinned celsian and paracelsian from the Benallt mine, on the Llyn Peninsula. Newer species are also represented, with photomicrographs of brochantite, connellite, devilline, langite, schulenbergitte, susannite and wroewolfeite.

The black-and-white annotated sketch maps showing the locations of former mines are very helpful, but otherwise it is not always easy to know which particular area of the Principality is being described. Clearly one must be armed with an appropriate ordnance survey map to tie down a specific locality, but for those readers less familiar than the author with the relatively new administrative boundaries in Wales, the inclusion of a sketch-map showing the whereabouts of Gwynedd, Powys and Dyfed would have been helpful — though often in