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BOOK REVIEWS

THE CRYSTAL CHEMISTRY AND PHYSICS OF METALS AND ALLOYS. By W. B. Pearson. John Wiley and Sons, Inc., New York, 1972. 806 pages. $34.95.

Out of the conviction that ". . . the crystal chemistry of metals is something that can be approached in its own right" (p. *vi*), Pearson has written a volume that combines extensive discussion of the chemical and physical factors that influence the formation of particular structures (chapters 1 through 6, 300 pages) with descriptions of some six hundred metal and alloy structure types (chapters 7 through 16, almost 500 pages). Throughout the book organizational and descriptive emphasis rests on stacking of atomic layers. Within this scheme the close-packed layer becomes just one specialization of two-dimensional nets of atoms.

Chapter 7 deals with structures based on close packing of close-packed nets, while chapter 8 discusses the many structures formed by filling of tetrahedral, octahedral, or other interstices in close-packed arrays. Here are found, among others, descriptions of structures derived in any of several ways from the sphalerite, wurtzite, fluorite, halite, and NiAs structure types. Further chapters describe structures based on triangular prismatic coordination, body-centered cubic packing, and arrangements of complex atomic layers including square-triangle nets, kagomé nets, and nets yielding icosahedral and higher coordinations. Interestingly enough, there are some fifty structures that Pearson catagorizes as "idiosyncratic" because they do not submit readily to his classification based on stacking of two-dimensional nets. Among them are black phosphorous, realgar, orpiment, cinnabar, millerite, and several other sulfides and sulfosalts.

Individual structure descriptions include cell dimensions and formula units per cell, but, unfortunately, only rarely include explicit statements of either space group or point group. The various coordination polyhedra, their relative arrangement, and some bond distances are usually given. Structure diagrams are plentiful; those in perspective showing coordination polyhedra or bonds are more useful than the equally numerous two-dimensional projections. There are no stereoscopic diagrams. Each structure description contains at least one reference to the original literature; these are generally up to date through the late 1960's, although in a few cases reference is made only to an early *Strukturbericht* volume. The minerals included in this compendium are restricted, with few exceptions, to those exhibiting metallic or semiconducting properties. Understandably the coverage is neither mineralogically comprehensive nor consistent. Although, for example, both troilite and smythite are described, there is no mention of pyrrhotite.

In his first six chapters Pearson discusses the crystal chemistry of metals and alloys with the objectives of rationalizing his own scheme of classification and description of structural units, and of evaluating the various factors that influence the stability of particular structure types. The interested mineralogist will profit from Pearson's attempt to interrelate geometrical factors like coordination, atomic size, and packing with chemical bonding considerations arising from electronegativity differences and energy band factors. The systematics of sulfide and sulfosalt mineralogy are not well understood, compared, say, to silicates, precisely because no one simplistic structural model can accommodate adequately to the complex interplay of competing influences. In this sense the classical crystal chemistry frequently presented to mineralogy students is woefully inadequate, and more exposure to the kind of analysis these chapters exemplify could improve the students' grasp of the subject significantly. The reader must, however, turn elsewhere for the fundamentals of the electron theory of metals and valence bond theory; suitable references are given in the text.

Chapter Five, "Valence compounds of metalloids: crystal chemistry of semiconductors," is perhaps the most satisfying of the entire book. After contrasting metallic and semiconductor bonds, and describing the bonding characteristics of several semiconducting structures, Pearson compares metals, semiconductors, and ionic compounds with common structures. Here one begins to appreciate in a way that simply doesn't come across in more classical crystal chemistry texts how size, chemical bond, and electronic factors interact to determine structure type. The chapter ends with a discussion of crystal field effects in transition metal compounds that is brief but gives several detailed illustrations of, for example, phases exhibiting Jahn-Teller distortions, as well as appropriate literature references.

In spite of my impression that this book's treatment of crystal chemistry is well worth the mineralogist's attention, I can not recommend it to students as anything beyond a reference work for structure types and access to the literature. The intellectual impact is seriously impaired, in my opinion, by a writing style that is extraordinarily awkward and confusing. Clumsily constructed sentences require perseverance and dedication if the reader is to appreciate fully Pearson's obviously skilled grasp of the subject. It is too bad such scientific insight is so obscured in the "noise" of the communication medium. The book will, nevertheless, be a useful addition to institutional mineralogical libraries.

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CLAY MINERALS: A GUIDE TO THEIR X-RAY IDENTIFICATION. By Dorothy Carroll. The Geological Society of America. Special Paper 126. 80 pages. $3.00.

Techniques of separating, mounting, and X-ray diffraction analysis of clays, as these were employed by the author, are described in this book. In addition, brief descriptions of the principal clay minerals and some comments on the origin and weathering of these minerals are presented. Mass absorption coefficients, calculated by the author for 25 clay minerals or minerals sometimes associated with clays, as well as numerous useful tables and diagrams from the literature, are presented. The book should be useful to

students as well as teachers of clay mineralogy. Other works on the subject should be consulted, however, if routine clay mineral analyses are made. Some of these references are cited in the book.

Although the effect of potassium saturation on vermiculite is described by the author, this important reaction is not included in the general procedures that are described. Evaporation of ethylene glycol from some montmorillonites is, under certain conditions, a reason to use glycerol for solvation rather than ethylene glycol as proposed. Solvation also is affected greatly by cation saturation and the proposed procedure should be modified to take advantage of these effects.

Widely different techniques are currently employed by clay mineralogists. This is probably accounted for by the varied disciplines represented and materials studied. Other workers in this field should be encouraged to publish their procedures and eventually improved as well as more uniform methods should be adopted.

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GEMSTONES. By G. F. Herbert Smith. Revised by F. C. Phillips. 14th Ed. Pitman Publishing Corporation, New York, 1973. xii + 580 pages. $24.50.

This book of long standing excellence through 13 editions since first published in 1912 is now revised by Professor Phillips, Emeritus Professor of Mineralogy and Petrology, University of Bristol. Revision includes the following: minor additions in crystallography, additions with photographs of inclusions, description of modern methods of corundum synthesis, and reference to corundum rods first developed by Linde Air Products Corporation in the war effort, flux fusion methods of Bell Telephone and their hydrothermal synthesis (not commercial) of corundum, synthetic emeralds of the several types, the new high optics synthetics—strontium titanate and yttrium garnet.

The fundamental optical coverage is retained, with added photographs of modern instruments. There is added coverage of sawing methods of diamond, and pictures of the primitive old diamond mining methods. The discussion of the cultured pearl industry and its procedures is expanded.

The section on diamond includes a discussion of the genesis of diamond and its mode of emplacement in the pipes from a probable depth of "190–555 Km". Coastal diamond deposits are also discussed including their genesis.

Six superb color plates add considerable glamor. They are clear enough to be instructive for the average reader.

Throughout the book, added photographs up-date the earlier edition to make the reader aware of new methods and new findings. The bibliography is extensive and the tables are expanded.

Mineral description and occurrence are covered in 300 pages, continuing the strongest feature of this popular and reliable reference work. It will serve jewellers and other professional gemologists today as the earlier editions have done over the years. It is a splendid addition to the library of those who have a deep interest in gemstones.

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SYNTHETIC GEM AND ALLIED CRYSTAL MANUFACTURE. By Daniel MacInnes. Noyes Data Corporation, Park Ridge, New Jersey, 1973. 221 pages. $24.00.

Noyes Data Corporation specializes in publishing technical reviews and handbooks, and this book by Daniel MacInnes is little more than a compilation of 112 of the more important patents issued for gem manufacture since 1911 when A. V. L. Verneuil obtained protection of the U.S. Patent Office for his eminently successful process for synthesizing sapphire by flame fusion.

There are 14 patents listed for the synthesis of corundum, 5 for "gems" with asterism, 8 for rutile, 12 for titanates, 8 for garnets (including the important laser crystal, YAG), and 9 for a variety of "gems" ranging from jade to cat's eye and from opal and lapis lazuli to emerald. More than half of the book (116 pages) is devoted to 35 processes for synthesizing diamonds, beginning with the famous Hall method first announced to De Beer's and the world by the General Electric Company in 1955 (but not granted patent protection until 1960) and ending with a most recent patent (July, 1972) obtained by George C. Kennedy.

In this book the author (compiler) has attained his stated purpose: "to describe the number of technical possibilities available" for synthesis of gems and related crystals. However, I disagree with his statement that "One should have to go no further than this book to establish a sound background before launching into research in this field." Although the book contains an abundance of technical detail (including 41 elaborately detailed figures of apparatus, furnaces, and process-related miscellany), there has been no attempt by the author to extract and systematize the vast body of scientific knowledge that underlies these remarkable technical accomplishments. The book will be a handy reference for industrial gem and mineral producers and their technical staffs, but mineralogists may find it disappointing.

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