BOOK REVIEWS

Minerals and Reactions at the Atomic Scale: Transmission Electron Microscopy. P.R. Buseck, editor. Reviews in Mineralogy, Volume 27, 1992, 508 pages. Mineralogical Society of America, Washington, D.C. US$28 (ISBN 0-939950-32-4).

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This volume represents the proceedings of a short course on Transmission Electron Microscopy (TEM), held October 23–25, 1992, at Hueston Woods State Park, College Corner, Ohio. The first five chapters give an excellent and up-to-date review of principles of TEM and microanalysis in the TEM, including high-resolution TEM and convergent-beam diffraction methods. The remainder of the book deals with applications of these techniques to many fascinating problems in mineralogy, where the possibility of examination at resolutions down to atomic plane imaging permits analyses until now impossible. Chapters are devoted to nonstoichiometry, polysomatism, and replacement reactions in minerals, to polytypism and stacking disorder, to mineral definition, diagenesis and low-grade metamorphism of shales and slates, to growth and alteration microstructures in carbonates, to analysis of deformation in geological materials and to the imaging of transformation-induced microstructures. Three features will be particularly appreciated: firstly, attention is paid to methods of sample preparation, which can be quite complex for certain materials; secondly, the reader is alerted to several potential difficulties and traps so that he or she may minimize the possibility of misinterpreting information; finally, all chapters include numerous up-to-date references for the reader who requires more detail. The introduction to the principles of TEM in the first chapters will make the book of value to workers even with relatively little previous experience in TEM, although some experience in diffraction methods and in crystallography is assumed. However, the work will be of most use to those who already have a certain background in TEM, as the subject is complex; as the editor points out, whereas modern TEMs are quite user-friendly, the range and quality of information obtained increase in direct proportion to the experience of the TEM operator. Those with experience in TEM methods will find the first chapters a very useful review of the field, and will be able to extract the greatest benefit from the specialized applications given in the last chapters.

Although directed primarily to mineralogists, much of the material covered in this really beautiful and modern book will be of interest to all persons using TEM in the study of crystalline materials, including earth scientists, metallurgists and physicists. At $28, this book is excellent value for money.

Handbook of Alloy Phase Diagrams, Volume 3. Edited by Hugh Baker. ASM International, Materials Park, Ohio 44073–0002, USA, 1992, 512 pages. US$130 (hardbound) (ISBN 0-87170-381-5).

This volume represents the third in a series begun with "Pearson's Handbook of Crystallographic Data for Intermetallic Phases (second edition)" by Pierre Villars and Larry D. Calvert, which was reviewed in *The Canadian Mineralogist* **30**, 236, and "Atlas of Crystal Structure Types for Intermetallic Phases" by Jo L.C. Daams, Pierre Villars & Jan H.N. van Vucht, which was reviewed in *The Canadian Mineralogist* **30**, 463. The contents are an introduction to phase diagrams relevant to alloys (30 pages); 1100 binary phase diagrams with a table of phase, composition, Pearson symbol, and space group (384 pages); 313 ternary phase diagrams (60 pages); an appendix of tables (20 pages), and an alloys and subject index (10 pages). This represents a summary version of phase diagrams, which includes the most important for the practicing engineer.

These diagrams represent useful information in checking the chemical formula and probable existence of many sulfide minerals. At present, there are a number of sulfide minerals listed in the "Glossary of Mineral Species" by Fleischer and Mandarino, for which no X-ray diffraction data are available, that may be checked by use of this volume.

Dienerite, Ni_3As, does not occur in the As–Ni binary alloy diagram, since the composition rests between Ni and Ni_5As_2. Therefore, dienerite is a questionable mineral. Silver-2H and silver-4H do not occur in the Ag diagram, and the possibility exists that the minerals described are similar to allargentum $Ag_{1-x}Sb_x$ and that the small amount of another element was not detected. Therefore, silver-2H and silver-4H are questionable minerals.

Horsfordite, $Cu_5Sb(?)$, occurs in the Cu–Sb binary diagram, and may represent the gamma metastable phase at Cu:Sb = 5:1, with the Pearson symbol of hP2 in space group $P6_3/mcc$ between temperatures of 488 and 400°C, or the delta stable phase at a Cu:Sb of about 4:1, with the Pearson symbol of hP? in space group $P6_3/mcc$. Therefore, horsfordite appears to be a valid mineral with the chemical formula of (Cu,Sb) with $Z = 2$.

The diagrams are easy to read, with good type definition to show the various temperatures and chemical formulas. Both weight percent and atomic percent are given in the diagrams; however, the table at the side of

the diagram is given only in weight percent. The book represents good value for money. Mineralogists interested in sulfides will want to acquire a copy of this publication.

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Mineral Powder Diffraction File Databook, Sets 1–42 and *Mineral Powder Diffraction File Search Manual, Sets 1–42*. P. Bayliss, R.C. Erd, M. Mrose, A.C. Roberts and A.P. Sabina (Editors). International Center for Diffraction Data, 1601 Park Lane, Swarthmore, Pennsylvania 19081–2389, U.S.A. (new address: Newton Square Corporate Campus, 12 Campus Boulevard, Newton Square, Pennsylvania 19073–3273, U.S.A.), 1993, 1377 pages in two volumes.

This new edition of the *Mineral Powder Diffraction File* by the ICDD (formerly the JCPDS and, previous to that, the ASTM), represents a very substantial advance over the previous 1986 "Red Book" edition. The number of records has been increased from 3400 in the previous edition to 3800 in this one, the increase representing mostly new minerals introduced in the intervening years, but also including data for older minerals for which new information has been obtained by means of "Grants-in-Aid" sponsored by the ICDD, or old information dredged up from obscure literature sources. Some 3200 mineral species are covered.

In the *Databook*, the records are listed alphabetically by mineral name, as in the previous edition, and the familiar "card" format is retained. The data for each mineral are arranged in the same format as previously, with eight areas per card, as follows: 1) the mineral name and PDF number; 2) the chemical formula, the chemical name, and the mineral name; 3) the experimental conditions, including radiation, wavelength, filter, method used to measure interplanar spacings, *d*-value cut-off, method used to measure intensities, and a reference to the source of the data; 4) physical data, including crystallographic system, space group (3-dimensional space-group symbol and space-group number), crystallographic parameters, measured and calculated densities, a reference to the source of the physical data, and a "figure of merit" (see below); 5) optical data with source reference; 6) general comments on pertinent information not contained elsewhere, including the Pearson Symbol Code; 7) a "quality" symbol based on compositional data, method of intensity measurement, and measure of agreement between calculated and reported *d*-values; and 8) a table to interplanar spacings in terms of *d* (Å), intensity on a scale of 1 to 100, and *hkl* indexing.

A useful addition to this part of the *Databook* is the name of the mineral, in bold print at the top left of each card. This makes it easy to spot the mineral name at a glance instead of having to look through the card to find it, as previously. Another innovation is the inclusion of a Smith–Snyder "Figure of Merit" (SS/FOM) for each data set. The SS/FOM is a function of the average absolute discrepancy between observed and calculated 2θ values and the number of independent diffraction lines.

There are six data records on each page, twice as many as previously, entailing a larger format, with "landscape" orientation. Twelve records are therefore exposed on one double page. The first and last names of the twelve are entered in large bold print at the top and bottom of the double page, making it easy to locate a specific mineral name.

This edition of the *Databook* has an Appendix that contains graphical representation of the diffraction patterns of 18 minerals. These minerals are mostly layer silicates whose patterns are difficult to distinguish. It would be nice to see this compilation expanded, as 18 minerals represent a pitifully small fraction of the mineral kingdom, but a compilation of such patterns for all mineral species would require an additional volume roughly the size of the *Databook*.

The *Search Manual* has a number of different search systems, some of which are new to this edition. The Hanawalt and Fink Indexes adhere to the customary procedures of listing the strongest eight reflections in searchable format, followed by the mineral name, its chemical formula, and PDF number.

The Chemical Name Index is an alphabetical index of chemical components of the minerals in the database. Some of the chemical names are permuted; gorceixite, for example, is listed under "Aluminum Phosphate Hydroxide: Barium", "Barium Aluminum Phosphate Hydroxide", "Hydroxide: Barium Aluminum Phosphate", and "Phosphate Hydroxide: Barium Aluminum".

The Group List Index, new to this edition, is a comprehensive alphabetical listing of mineral group names, subgroup names and, within each subgroup, an alphabetical list of mineral species with *a*, *b* and *c* unit-cell parameters and chemical formula. This index is particularly useful if one has a diffraction pattern characteristic of a group, and a rough chemical composition; the entries under the particular group heading can be scanned rapidly to find a reasonable match to a species.

The Axial Ratio Index, also new to this edition, lists the records in order of increasing *a/b* ratio. Additional information included in this Index are the crystal system, the *a*, *b* and *c* unit-cell parameters, the *c/b* ratio, cell volume, chemical formula and, of course, the mineral name and PDF number. This index can be used where the crystallographic parameters of a mineral are known from single-crystal data, indexed powder patterns, or even goniometric measurements.

The Pearson Symbol Code (PSC) Index is another innovation. The Code is composed of the Pearson

Bravais lattice mnemonic followed by the number of atoms in the observed structure. The Index places together all entries with a given PSC, and also gives crystal system, space group, the *a*, *b* and *c* cell parameters, unit-cell volume, chemical formula, mineral name and PDF number. This enables structural similarities to be recognized in chemically dissimilar minerals.

Finally there is a PDF Index, which lists the mineral patterns in the PDF file according to the PDF number.

For the user, there are straightforward explanations of the different types of data and indexes, together with instructions on the effective use of search methods.

The *Mineral Powder Diffraction File* is an authoritative compilation, not only of powder-diffraction data, but also of mineral data, generally. It follows the recommendations of international technical committees – for mineral nomenclature, the IMA Commission on New Minerals and Mineral Names; for chemical formulae, the IUPAC *Nomenclature of Inorganic Chemistry*; and for crystallographic nomenclature, the *International Tables for X-ray Crystallography*.

The *Mineral Powder Diffraction File* is part of a larger comprehensive compilation of data on inorganic and organic compounds compiled by the ICDD over a period of many years, and systematically reviewed and upgraded. It can be regarded as the definitive compilation of powder-diffraction data for minerals, and is an essential tool for anyone concerned with mineral identification. The price of $US750 for the *Databook* and *Search Manual* will seem daunting to some organizations, but where else can you get this wealth of information in one package? The nearest competitor is the PDF–2 computer database on magnetic tape with a price tag of $US4,500, or on a CD–ROM, priced at $US5,500, both available from the ICDD.

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Advances in X-ray Analysis, Volumes 35A and 35B. Edited by C.S. Barrett, J.V. Gilfrich, T.C. Huang, R. Jenkins, G.J. McCarthy, P.K. Predecki, R. Ryon & D.K. Smith. Proceedings of the combined First Pacific–International Congress on X-ray Analytical Methods (PICXAM) and Fortieth Annual Conference on Applications of X-ray Analysis, August 7–16, 1991. Plenum Press, New York. 1333 pages in two volumes. US$185 hardbound (ISBN 0-306-44249-3).

These volumes, as the full title explains, are the selected proceedings from a conference on applications and methods in X-ray analysis. They are collected under 15 headings that give a good idea of the scope of the work. These headings are: Whole Pattern Fitting, Rietveld Analysis and Calculated Diffraction Patterns; Quantitative Phase Analysis (XRD), Thin Film and Surface Characterization; Lattice Defects and X-ray Topography; Texture Analysis; Instrumentation, Techniques and Reference Materials; Stress Determination; XRD Profile Fitting, Crystallite Size and Strain Determination; XRD Applications: Detection Limits, Superconductors, Organics, Minerals; Mathematical Methods (XRS); Thin Films and Surface Characterization (XRS, XPS); XRS Techniques and Instrumentation; XRS Applications; X-ray Imaging and Tomography.

The contributions to the proceedings were obviously provided in camera-ready copy, and the editors have selected from among these. Whereas the presentation therefore inevitably changes from article to article, they are uniformly well prepared, and legible, with clear, sharp diagrams.

The work is thus a snap-shot of the developing areas of the subject in 1991 rather than a considered work of reference. However, the editors have selected carefully to produce a comprehensive range of topics, with an overall standard of the contributions that is strikingly high. The range goes from the description of an inexpensive but effective secondary internal standard for low 2θ values to augment the regular silicon standard for powder diffraction to, for example, nonlinear mathematical equations for the accurate orientation of crystal faces. Many of the applications sometimes sparkle with secondary interest: the XRF analysis of the metal of the cascabels of the cannons (illustrated) from which the British Victoria Crosses are made comes to mind; the metal comes from two cannons, not one as is often quoted, and the cannons, though brought back from Sebastapol, seem to have been cast in Asia, probably China, and not in Europe!

Those who go to the section on Rietveld analysis will find something on powder diffraction and the determination of general crystal structures, but the publication was perhaps a little too early to catch the recent growing interest in this field. However, there is a discussion of an imaging plate and imaging plate technology that brings this important developing aspect of the subject out of the company journals into the regular scientific literature.

The two volumes have a table of contents only in Volume A and an index only in Volume B. The table of contents proved somewhat better than the index for locating contributions of interest and, though a small point, the books would be less irritating to use if at least the table of contents had been in both volumes.

At $185, the books are not too expensive, and those working in the field of X-ray analysis will need to have access to them at least in a conveniently close library. This particular reviewer has found them most useful, and would not now want to be without his own copy.

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