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BOOK REVIEWS

During the last decade, few mineralogy reference books were published. Recently, however, a number of books with and without computer databases have appeared, and it is most fortunate that we can group in this issue six reviews of mineralogy reference books or databases. Those who read all six reviews will notice the vigorous discussion about the relative merits of a book *versus* a computer database.

In the future, publication may be expected of a number of mineralogy reference books such as *Chemical Index of Minerals* (second edition) by Andrew M. Clark, R.F. Symes and A.R. Woolley of the British Museum, *Crystal Data of Minerals* by Mary E. Mrose of the National Institute of Standards and Technology (formerly N.B.S.), *Klockman's Mineralogy* (seventeenth edition) by Hugo Strunz in both German and English, *Dana's System of Mineralogy* (eighth edition) by Eugene E. Foord *et al.*, Glossary of Mineral Species (sixth edition) by Michael Fleischer, *Mineral Powder Diffraction File* (fourth edition) from JCPDS - International Centre for Diffraction Data, and a book form of *MINERAL* by Ernie H. Nickel and M. C. Nichols. We look forward to reviewing these in future issues of this journal.

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Handbook of Mineralogy. Volume I. Elements, Sulfides, Sulfosalts. By J.W. Anthony, R.W. Bideaux, D.W. Bladh, and M.C. Nichols. Mineral Data Publishing, Tucson, Arizona, 1990, vii + 588 pages, ISBN 0-9622097-0-8. US $ 82.50.

This book is volume I of a projected series covering the entire mineral kingdom. It deals with the elements, sulfides, sulfosalts, alloys, antimonides, arsenides, bismuthinides, intermetallics, selenides, sulfhalides, sulfoxides and tellurides. The treatment of each mineral is equal in the sense that it is restricted to one page per species. On that page one finds a synopsis of available information under the following headings: Crystal Data; Physical Properties; Optical Properties; Cell Data; X-ray Powder Pattern; Chemistry; Occurrence; Association; Distribution; Name; Type Material; and References. The book covers 588 mineral species, arranged alphabetically. It is cloth bound and clearly printed on high-quality paper, as befits a book that is obviously intended as a work of reference.

This is the first work of its kind in the English language since the *Dana's System of Mineralogy,* which has aimed to cover all known mineral species, a task which, with the proliferation of journals and publications in mineralogy and related areas, has become more daunting with each passing year. Of course, a one-page-per-species treatment cannot be equated in any way with the more detailed coverage offered in Dana for the more common species, nor that given many minerals in specialized texts. However, the team of authors is to be congratulated for having had the courage to grasp the nettle and make an attempt to winnow, from the deluge of information published in more than a dozen languages worldwide, the concise single-page presentations they offer.

The sections on crystal data may include (as available) information on symmetry, point group, habit, mode of aggregation and twinning. The physical properties documented include hardness (Mohs and VHN), density, cleavage, fracture and tenacity. Under optical properties are included those of hand specimens as well as properties that can be observed by reflected light microscopy (color, pleochroism and anisotropism). The minerals covered in this volume are generally opaque, so that transmitted light characteristics are generally absent. Reflectance values are frequently given for as many as 16 different wavelengths (rather than the four standard wavelengths of 470, 546, 589 and 650 nm). This detailed presentation, which one finds in more specialized books such as the "Quantitative Data File", published by the British Museum, consumes a significant amount of space which, one feels, might have been devoted to other pertinent information. The cell data sections include space group and the cell dimensions. It is not apparent whether these data are averages or from individual samples, and if the latter, where those data were obtained. The X-ray powder pattern contains the *d* values and relative intensities of the seven most intense lines, arranged on the basis of decreasing intensity. Unfortunately, the opportunity was not taken of listing the PDF number where one could obtain the complete pattern for a species. This would have fitted easily on the same line as the *d* values and although, in time. it would have become out of date, no more so than some of the other information presented. Chemistry is perhaps the most disappointing summary of available information. Generally it contains one or two analyses (a maximum of four), which are sometimes compared with a composition calculated from the theoretical formula. In most but not all cases,

the concentrations given are limited to those for elements appearing in the theoretical formula. Whilst this may be all that is possible for some rare minerals and perfectly satisfactory for others, it does not do justice to widely studied minerals such as those of the tetrahedrite–tennantite series, the common sulfide sphalerite, or even native elements such as silver. For example, published data for tetrahedrite includes six or more elements, which may appear at levels that are above 3%, but that are not even mentioned in the brief tabulation given. This failure to cover adequately the published compositional range of common elements, and the omission of data for minor and trace elements, leaves one wondering how the authors will tackle the challenge of giving adequate compositional coverage to complex silicates (particularly *REE*-bearing silicates) in any subsequent volume covering those minerals. Under the heading *polymorphism and series,* information also is given on polytypic variations. No other information on classification appears in the book. *Occurrence* gives information on the types of geological environment or kinds of deposit in which a mineral usually occurs, and *association* is a useful section that lists (not exhaustively) minerals known to be associated. Under the heading *distribution,* one finds a summary of the principal localities at which the mineral is known to have been found. Type localities are not distinguished. *Name* is generally a one-liner giving the origin of the name, and under *type material* is given the physical location (museum, *etc.*) of the specimen from which the species was originally described. The principal references are presented with literature searches extending "through 1988".

One of the great difficulties in producing a work of this kind, which is, in effect, a solid mass of information, is maintaining high standards of accuracy and avoiding typographical errors. Here the authors seem to have succeeded admirably. Although it is impractical for a reviewer to check data exhaustively, in one hundred items selected randomly, not a single error was identified.

New mineral names are being approved at the rate of roughly about 50 every year. Thus this book, like others of its kind, faces the certainty of becoming progressively more incomplete with the passage of time. Perhaps it is time that publishers took a leaf out of government practice, where many manuals are issued in nine-ring binders, with periodic updates and additions being made available. At $82.50 (US) plus shipping and handling, the Handbook of Mineralogy, Volume 1, is not cheap. An updatable format might have made it a much more attractive investment.

Who will use this book? It clearly is not aimed at the undergraduate or graduate student market, but rather at research institutions, museums, libraries and, to some extent, the individual researcher. At present, competition comes from the less complete but more comprehensive Encyclopedia of Minerals (Roberts *et al.* 1990; see below), which contains details of more than 3,000 species with color photos of nearly 400 of them. Illustrations in the *Handbook of Mineralogy* are limited to a drawing of an epitactic overgrowth of tennantite on octahedral pyrite imprinted as a motif on the buckram cover! Future competition may come from a proposed 8th edition of *Dana's System of Mineralogy,* work on which is presently underway. One learns from the acknowledgements that this book was prepared and typeset from a computer database. Thus perhaps the real competition for books of this kind comes from the computer databases and associated programs for mineral identification that are presently being developed and becoming commercially available in several countries. Although such software is generally appreciably more expensive than even a reference book, it enjoys several advantages: it is readily updatable, hard copy can be generated as needed, it can be made much more comprehensive in its coverage, and it can be made a very much more powerful tool in determinative mineralogy. Indeed one can readily envisage a time in the not too distant future when hypermedia databases (numerical, text, graphics, image and even sound) will replace such reference texts entirely.

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Chemical and Determinative Tables of Mineralogy. Silicates. By Roland M. Pierrot and Fabien F. Cesbron. Bureau de Recherches Géologiques et Minières (BRGM), Orléans, France, 1989, 308 pages. 700 FF.

This book is unusual in that it classifies the silicates purely on the basis of their chemical compositions. The book is in a horizontal format, which allows for 41 columns after the name and chemical formula of the mineral, each column being allotted to a specific element. The minerals themselves are grouped according to a major element other than silicon. For example, the first grouping, under lithium, contains some 40 minerals in which lithium is an important element; the columns following the formula then indicate which other elements may be present in appreciable amounts. The minerals themselves are listed in the order of the year of their discovery. These data in themselves are more than a little interesting, but speed of reference would have been gained by an alphabetical listing. The rationale given for this is that new minerals can be added without disturbing the format. Following the table, a brief description (crystallographic data, chemical composition, references) is given of the minerals in

which the given element (in this case, lithium) is the major constituent (in weight percent). This results in only one mineral being described under lithium, in this case, liberite. To find more details about, for example, petalite, one must look under *Aluminium*. However, an alphabetical listing of all the minerals at the end of the book gives the pages on which they may be found.

The authors have clearly compromised on the basis of a rigid and simple classification that can be useful, for chemists especially, in identifying these minerals. With the widespread use of the scanning electron microscope, these tables give a rapid means of narrowing down the identification of unknown minerals. It is not very helpful, of course, for lithium and beryllium minerals; in these cases at least, it would have been useful to include indices of refraction as an extra aid.

For minerals described after 1960, the five strongest lines of their X-ray-diffraction pattern are given; it is a pity that this was not done for all minerals listed.

References up to 1988 are included; the book is clearly printed, and contains few blemishes. Curiously, there are quite a number of misprints amongst the names of authors in the references, one or two being amusing. Ms Quodling seems to have been given Chinese antecedents by printing her name as Quod Ling! Nevertheless, this can be a very useful compilation for the professional mineralogist and chemist, especially those who make frequent use of the scanning electron microscope to examine their material. I would indeed be happy to have a copy on my desk.

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Systematics of Minerals. By Alexander R. Hölzel. Hölzel, Ulmenring 11, D-6501 Ober-Olm, Germany, 1990, 40 + 584 pages, DM 380.00 + DM40.00 for postage and handling in USA and Canada.

The main part of the book consists of data on approximately 3,500 minerals, arranged according to a system derived from that of Strunz. The data for each mineral include name, systematic number, chemical formula, "synthetic formula", crystal system, space group, *Z* (formula units in cell), unit-cell parameters, density, Mohs hardness, three X-ray reflections with strongest intensities, indices of refraction, optical class, color and streak. Separate chapters give literature references (35,000 entries up to August 1989) by mineral, listings of minerals by crystal class and space group, chemical tables by element, and classifications for different properties of 318 rock-forming minerals. The data are also available as an IBM-compatible computer database (MDAT) with search program (then with up to 16 X-ray reflections and with birefringence added to the optical data); MDAT costs DM 2,950 (about CDN $2,300)!

There is no doubt about the fact that Hölzel has carried out a tremendous effort in compiling such an enormous database (book or computer); the mineralogical community should be grateful to him for taking a lot of work off our hands. But a book proclaiming itself to be a replacement for the legendary tables of Strunz should be closely inspected, to see whether it really stands up to such a challenge. The results of the inspection are disappointing. It is far too easy to find within a short time hundreds of typographical errors, from bars printed through numbers instead of above them to straight misprints or mistakes in the actual numbers. The value of a database diminishes rapidly when the included data cannot fully be trusted.

The crystal-chemical classification itself has three major shortcomings. The author has attributed a systematic number to each mineral; this is not only superfluous (a mineral is identified by name and formula), it will also cause much confusion in the future. When the position of a mineral changes in the classification for some reason, something that happens quite often, the number also must be changed because otherwise a very strange pot-pourri will be created after only a few years. But this so-called systematic number already leads to much confusion at present, because not only minerals have been given numbers, but also because many varieties have been given species-equivalent status. The numbers are intended, among other things, to facilitate the management of collections. But what should one do with a specimen of fairly green and more or less transparent beryl? Shall we put it under 8.CC.100 of beryl, under 8.CC.102 of emerald, or perhaps after some more consideration under 8.CC.104 of aquamarine? The long list of quartz varieties, including such ill-defined terms as ferruginous quartz, needle quartz and blue quartz, each with a separate systematic number, borders on the ridiculous. A second failure of the classification, perhaps a direct result of the systematic numbering, is the impossibility to incorporate the more than 600 unnamed minerals that have been reported until now: easy access to the data on these incompletely described compounds is mandatory in a modern reference work.

But the most serious problem of the book, in my opinion, concerns the classification itself. A few examples are given. Hölzel provides the most recent literature for nolanite: Gatehouse *et al.* have shown in 1983 that this mineral has a högbomite-type structure, and they presented new unit-cell contents. But Hölzel gives a different formula and puts nolanite

with the Vanadin (*sic*) oxides, whereas högbomite (not in the right place in the alphabetical index) has its own group. Brownmillerite and mayenite, Ca-Al oxides that constituted a separate group in the Strunz system, are now included with the Al-spinels; the logic of this classification becomes very obscure indeed when the Fe-analogue of brownmillerite, the Al-free srebrodolskite, also is placed under the Al-spinel! What is the reason for the author to change the hausmannite series of Strunz from tetragonal and orthorhombic Mn-oxide minerals to Mn-spinels, which they are definitely not? Many more examples could be given: Hölzel has certainly not followed the system of Strunz; in places only a vague resemblance remains.

The book has positive aspects also. The most valuable part is formed by the 94 pages with the 35,000 literature references. To my knowledge, this bibliography is the first comprehensive listing for all minerals in one single book. It is all the more valuable, because also for the first time references to (semi)-amateur journals have been included (*e.g., Aufschluss, Emser Hefte, Mineralogical Record, Schweizer Strahler*): many overlooked or neglected references for rare minerals are now readily available. There are, however, two drawbacks to the list. It has been arranged according to the systematic number of the minerals: one must first search for a number before being able to look up the literature. At least four different ways have been used to indicate year, volume and page numbers, but the author does not explain what way is used for which journal; so, one must find out for oneself that, *e.g.*, AM 68/496 is *American Mineralogist* 1968, p. 496; CM 78/16/651 is *Canadian Mineralogist* 1978, volume 16, p. 651; but MR 82/4/211 means *Mineralogical Record* 1982, issue 4, p. 211.

The book contains more inconsistencies: many abbreviations and signs used in the tables are not explained at all, space-group designations leave room for doubt, microscopic and macroscopic data are mixed in the color assignment. The author uses a "synthetic formula" based on the molecular formula, apparently to facilitate the chemical comparison of minerals by computer, but this system is inadequately explained and barely illustrated in the introduction.

Almost with pain in my heart I must conclude that so much effort will serve comparatively little use. For whom is the book intended? The professional mineralogist will be stunned by the many errors in classification and in numbers, the amateur mineralogist could use the systematic numbering to order his collection (a revival of the Dana collector?), but there are more simple ways to achieve the same result; both categories will use the bibliography, if they manage to decipher the system. There remains one big question: why did Hölzel not submit his manuscript to an expert mineralogist before going to a printer? Many problems could easily have been avoided by critically reading the accumulated data.

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MINERAL. By Ernie H. Nickel and Monte C. Nichols. Aleph Enterprises, P.O. Box 213, Livermore, California 94551, U.S.A., 1989, 36 pages + disks. US $249.

There is an alternative way for quick reference to updated crystal-chemical data. Such a way exists in the form of *MINERAL*, a computer database with retrieval program. The authors of this database have avoided the errors which are so prominent in the *Systematics of Minerals* by Hölzel, and they have creatively adapted the numerous new mineral data in a classification that also is based on that of Strunz. As a bonus, *MINERAL* is less expensive and really reliable.

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Encyclopedia of Minerals (second edition). By Willard L. Roberts, Thomas J. Campbell, and George R. Rapp Jr. with photographs edited by Wendell E. Wilson. Van Nostrand Reinhold, c/o Nelson Canada, 1120 Birchmount Road, Scarborough, Ontario M1K 5G4, 1990, xxxii + 979 pages. CDN $139.95, (ISBN 0-442-27681-8).

The second edition of this well-known volume has a similar format to that of the 1974 edition: an alphabetical tabulation by mineral name (from abelsonite to zykaite), so that an index is not needed. Under each mineral name heading is given the chemical formula, crystal system, crystal class, space group, Z (formula units in cell), unit-cell dimensions, three strongest X-ray-diffraction reflections, reflected light properties, transmitted light constants, hardness, density, cleavage, fracture, habit, color and luster, mode of occurrence, and one or more selected references in English.

The number of mineral species in this edition has increased from 2200 to 3200; however, the number of mineral species per page has remained constant at about three and a half. References up to 1987 have been quoted, and about a third of the references postdate the 1974 edition; however, some primary references to better data have been missed. Probably five references would be needed to reference all the data adequately. No book or database is free

from errors; however, this book contains more minor errors of fact than the average of the other available databases and books.

About 240 superb color photographs of beautiful mineral specimens arranged in alphabetical order by mineral name with three to six specimens per page on 48 pages make up the central section of this book. Another 100 black-and-white photographs (mainly taken with a scanning electron microscope) and 50 crystal drawings are inserted throughout the book. The quality of the photographs is significantly better than in the first edition. The quality is better than the average of the available "coffee-table-type" books. The tendency to photograph large well-crystallized specimens means that many mineral species found only as small specimens are not photographed.

Compared to other mineralogy books published in 1990, the price of this book, although it may appear high, is reasonable. This book is suitable for geology libraries and scientists who would like to have a single-volume mineralogical reference work on their shelf.

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MinIdent, A Users' Manual for Mineral Identification. By Dorian G.W. Smith & D.P. Leibovitz. Astimex Scientific Limited, 351 Wellesley Street East, Toronto, Ontario M4X 1H2, 1990, vii + 100 pages plus disks. CDN $995.00.

The manual describes the purpose of MinIdent (mineral identification), which was initially written to identify unknowns from electron-microprobe data. Unknowns are matched against compositional data from the literature for preference; however, where these are unavailable, then the calculated range of data is used. The database includes either the average chemical percentages with standard deviations or the maximum or minimum chemical percentages. Since the chemical compositions of many minerals exhibit a wide range in solid solution, a matching index is calculated for each possible mineral on the basis of the overall similarity between the chemical data of the various possible minerals and the unknown.

Chemical composition alone will not distinguish one polymorph (*e.g.*, quartz, cristobalite, tridymite) or polytype (*e.g.*, molybdenite-2H, molybdenite-3R) from another. Therefore, in such cases, other properties, such as coordination numbers, transmission and reflected optical properties, *d* values of the five strongest reflections, unit-cell dimensions, symmetry, space group, mineral classification, Mohs hardness and indentation hardness (VNH), density, polymorphs, remarks, occurrence, location(s), and references are available, including a range of values in the database.

The commands to use the database are few and simple: unknown, display, identify, match and tabulate. The syntax of the conventions to enter the data of the unknown is wide, since three to six letter abbreviations are often allowable in mixed-case letters. Often a common synonym may be used, so that the infrequent user does not have the difficulty of remembering a wide range of computer syntax.

There are a series of examples to show the different types of data that may be entered to find an identification. In addition, the examples show how to enter the data with the greatest reliability first and then to save time with a secondary search. Large amounts of information will just overload the system. The matching index increases if the database lacks data for the particular properties given for the unknown. A list of reference books and journals articles are given for each mineral.

The reviewer entered two pieces of data into the system for a number of minerals including clinochlore and erdite to find that they appeared high on the matching index tabulation. The use of a sophisticated matching index rather than a "black-white" solution is an excellent feature. The database contains about 600 unnamed minerals, which is significantly higher than other sources of unnamed minerals. The use of the year in the unnamed minerals together with a trivial number is significantly better than the use of a trivial number only, like in *MINERAL,* which has only 300 unnamed minerals. A list of unnamed minerals with *d* values did show a few errors of fact, but nothing worse than average for a database.

MinIdent is successful in the fast identification of monomineralic specimens from two or more pieces of quantitative data. Such a system is highly recommended for a laboratory that routinely identifies minerals.

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Illustrated Glossary of Petroleum Geochemistry. By Jennifer A. Miles. Oxford University Press, Oxford, 1989, ix + 137 pages, US $43.95 (hard cover), ISBN 0-19-854492-8.

The text of this book is divided into two parts. The first Summary section has many tables illustrating such factors as kerogen nomenclature, bulk maturity parameters, and source-rock characteristics; these tables provide an overview of petroleum geochemistry. The suggested list of references is, however, neither exhaustive nor up-to-date. The main section is the copiously illustrated Glossary, with concise definitions of most terms used in organic

geochemistry. Words with homographic counterparts should have definitions for both usages; *e.g.*, tasmanite refers to an impure coal and also to an igneous rock, besides a species of alga, as defined in the Glossary.

The book provides an index-format rapid access to information in the field of petroleum geochemistry. With a quick reference to many synonyms, the Glossary would serve as a useful tool for both the exploration geochemists and the academic.

This excellent book is a good value for the price and should be held by all libraries and in the possession of field geologists.

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Magmatic Sulfide Deposits. By Anthony J. Naldrett. Oxford University Press, 1989, 189 pages. US$91 (cloth) (ISBN 0-19-505119-X).

Tony Naldrett has done for magmatic sulfide ore deposits what Don Sangster and others have done for volcanogenic massive sulfide ore deposits. Naldrett's access to world-wide information on magmatic deposits has enabled him to produce a compact, well-organized and understandable volume of both practical and academic use.

The text material is nicely arranged. The expanded classification of magmatic deposits and the comprehensive explanation of experimental data necessary to the understanding of genetic models of magmatic ore deposition are covered early in the book, and make the remaining portions of the book more easily understood.

The concept of fractional crystallization of mafic magmas as a process of Ni sulfide, Ni–Cu–Pt sulfide and platinum-group-element concentration has been present in economic geology for much of the twentieth century. The association of Ni sulfide and Ni–Cu–Pt sulfide mineralization with ultramafic and mafic rocks has long been recognized by exploration geologists. These basics have been expanded upon and are documented by a wide range of excellent examples. I particularly enjoyed the discussion of the Australian Ni sulfide deposits. The examples of ore deposits cited and the use of these descriptions to illustrate the concepts form the strength of the book. The figures accompanying these examples, and those of the geochemical portion of the book (Chapter 3), are well drawn and necessary to the understanding.

The composition of magmatic sulfide ores commonly is used as evidence of a magmatic origin. The author's treatment of this subject is exhaustive. I had to maintain a "scorecard" of chemical element ratios to refresh my memory in reading this chapter.

"This book is a comprehensive and detailed treatment" of a rather narrow subject. The treatment is at graduate level, and a knowledge of geochemistry at a very senior undergraduate or graduate level is assumed. Because of the narrow focus necessitated by the subject and because of its price, this book will be most useful as one of perhaps several texts in an advanced course in economic geology, available from university libraries, or as a very useful part of a professional economic geologist's library.

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Modern Powder Diffraction. Edited by D.L. Bish and J.E. Post. Reviews in Mineralogy, volume 20, Mineralogical Society of America, Washington, D.C. 1989, 369 pages. US $20 (soft-bound) (ISBN 0-939950-24-3).

Where other recent publications appear to be a conglomeration of papers on separate aspects of powder diffraction, *Modern Powder Diffraction* is an up-to-date, concise summary of the basic aspects of powder diffraction. Chapter 1 is a summary of the principles of powder diffraction. The following four chapters contain summaries of instrumentation in powder diffraction, experimental procedures, sample preparation and quantitative analysis. The later, more specific chapters contain information on powder diffraction by small and disordered crystals, computer analysis of diffraction data, profile fitting of powder-diffraction patterns, and Rietveld refinement of such patterns. The last two chapters are summaries of the synchrotron and neutron powder-diffraction methods and applications.

The quality of presentation is good, although it varies slightly from author to author. Despite this, a few misprints can be found throughout the book:
a) the equation at the top of page 62 should read $-\Delta\theta\cot\theta$;
b) the end of the equation at the top of page 81 should read:

$$\frac{3.2\sin\theta}{\mu}$$

c) the equation on page 291 should read GOF = (R_{wp}/R_{exp});
d) the bottom of the equation for R_{exp} on page 248 should be:

$$\Sigma[w(2\theta_i) \times (I(2\theta_i obs)^2].$$

This volume is geared to the graduate level and could serve as a textbook in a graduate course. It would also be a useful addition to a specialist professional's library. At a cost of US $20, *Modern Powder Diffraction* is an excellent value.

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