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BOOK REVIEWS

INTRODUCTION TO OPTICAL MINERALOGY. By William D. Nesse. Oxford University Press, New York, 1986. x + 325 pages, $41.95.

This book represents an attempt to combine optical crystallography and optical mineralogy into one handy volume. Many students of optical mineralogy have the need for such a book, which can be used conveniently to look up not only optical data and descriptions of minerals but also methods of measuring or determining optical properties for identification purposes. The author should be complimented for his success in achieving a good balance between two subjects while keeping the volume down to a reasonable and affordable size.

The first 7 chapters of the book are devoted to the basic principles of light and crystal optics, polarized-light microscopes and refractometry, and methods of measuring and interpreting different optical properties. The optical indicatrix was used throughout the text for explaining and analyzing optical properties. The illustrations are clear and well constructed. Basically, the optical crystallography section of this book provides the theories and methods necessary to understand and master the essential principles and techniques pertinent to studying and identifying nonopaque minerals in petrographic thin sections as well as in grain mounts. A more quantitative approach has been adopted to derive the refraction angle and refractive index of the extraordinary wave normal for inclined incidence cases in both uniaxial and biaxial crystals. I question the necessity of such in-depth discussions not only because they conflict with the concise and introductory nature of the book but also because occasional mathematic inaccuracies in the examples illustrating graphic solutions may cause confusion for beginning students. For example, in Figure 6.9*b* of the uniaxial case, the labels of the two curves should be transposed and their intersection point should be at $n'_\epsilon = 1.803$ and $\theta_\epsilon = 16.1°$. Apparently, the incorrect solutions (1.66 and 17.5°) given in the book must have arisen from the wrong positions of the two curves. Similarly, for the biaxial case (Fig. 7.10*b*), the curve representing Equation 7.5 is slightly off its correct position, which explains why the results obtained by the author ($n'_\epsilon = 1.564$ and $\theta_\epsilon = 18.7°$) do not fit Equation 7.5. Another error that came to my attention is the equation on page 31. Because dn/dt is a negative value, the plus sign in the equation should be replaced by a minus sign.

Chapter 8 is a unique chapter, which beginning students will find especially helpful in guiding them through "the sometimes daunting process of identifying an unknown mineral with the microscope." At the request of numerous students, the author has included a tabulation of minerals likely to be found in common rocks. Despite the apparent shortcomings to such tabulation, its usefulness should not be underestimated.

The optical mineralogy section of this book consists of seven chapters and covers common rock-forming minerals as well as some opaque minerals. Obviously, the author has spared no efforts to include the most updated optical data in descriptions. A very important feature of this book in presenting optical-compositional relationships is the use of bands instead of single lines in many optical migration diagrams. Such an approach will serve two purposes. First, as the author indicated, the unwanted impression of precision of those diagrams can be avoided. Second, and probably more important, attempts to distinguish different subspecies within a solid-solution series solely on the basis of optical information will encounter less confusion.

Three appendixes deal with sample preparation, ray-velocity surfaces, and identification tables. I fail to see the need for including ray-velocity surfaces in a book intended for an introductory optical mineralogy course. Appendix C contains 13 identification tables. Some of these tables, such as C9 through C12, will be especially welcomed by students of optical mineralogy and petrography. They focus on those theoretically unusual, but practically not uncommon, cases: isometric minerals that may be birefringent, uniaxial minerals that may give biaxial interference figures, anisotropic minerals that may appear isotropic, and biaxial minerals that may give uniaxial interference figures. Such nonideal or nonstandard cases often cause problems for students in routine identification of minerals in rock thin sections. Any guidance in this direction is extremely valuable for beginners.

There are two areas that have been frequently ignored by most optical crystallography and optical mineralogy textbooks: Kohler illumination and dispersion staining methods. This book is no exception. Considering the crucial role of proper illumination in quality photomicrography and the simplicity and effectiveness of dispersion staining in determining or estimating refractive indices of nonopaque solids, students of mineralogy and petrography would undoubtedly benefit from these methods. Nonetheless, even with these minor errors and omissions, this practical book will serve very well as an introductory-level textbook.

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ORIGINS OF IGNEOUS LAYERING (NATO ASI Series C: Mathematical and Physical Sciences, vol. 196). Edited by Ian Parsons. D. Reidel, Dordrecht, The Netherlands, 1987. 666 pages, $124.00.

This book is the proceedings of a NATO Advanced Research Workshop on igneous layering. The workshop was held near the sites of several layered alkaline intrusions in South Greenland and appropriately contains descriptive studies of these bodies (Ilimaussaq, Klokken, Tugtutoq). However, the scope of the book goes far beyond the field relations and petrography of these remarkable intrusions: contributed papers deal with experimental and theoretical aspects of fluid dynamics, the role of surface energy in affecting apparent cumulus texture and layer development, as well as updated studies of several other intrusions including the classic Skaergaard and Rhum intrusions. In addition to 20 research papers, there is a section of some 30 photographs and descriptions of layering not discussed elsewhere in the book. Also, in the Appendix, written by T. N. Irvine, there is a revised glossary of terms for layered intrusions and an outline of credible processes in layered intrusions that includes brief descriptions and references. Students and professionals alike will find both sections extremely useful.

As with many proceedings, the papers are of uneven quality and unfortunately the author-prepared type, which varies from paper to paper, is sometimes difficult to read. However, these shortcomings are largely overcome by the inclusion of several memorable papers and the high quality of the figures, photo-

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graphs, and photomicrographs. The book is roughly divided into two parts—first, the field-oriented papers and second, the theoretical and experimental studies—but as Parsons recommends, one should begin by reading the Appendix. Next, partly to reinforce the lessons in diction and partly as an introduction to the many types of layering, one should read Irvine's partisan, but eloquent treatise on layering in the Duke Island and Skaergaard intrusions. Personal preference will dictate what to read next, but some topics should not be overlooked. Petrologists familiar with descriptions of the most widely known layered intrusions (Bushveld, Kiglapait, Skaergaard, Stillwater) will expand their horizons by reading about the alkaline Greenland intrusions. Anyone who has puzzled over the inch-scale layering in the Stillwater intrusion will find A. E. Boudreau's model of pattern formation illuminating, if not compelling. R. H. Hunter's paper on surface energy and the development of textural equilibrium follows next and is not only an appropriate companion for Boudreau's paper, but it is also an important successor to the classic paper on igneous cumulates by Wager, Brown, and Wordsworth. Finally, there is a cluster of papers dealing with theoretical and laboratory modeling of magma chamber processes (crystallization along inclined planes, convection of intercumulus melt, time scales for crystallization) that are logically introduced by a short paper on dynamic similarity written by S. J. Sparks and H. E. Huppert. This paper contains a welcome discussion of the appropriateness of laboratory simulations of magma chamber processes.

Overall, *Origins of Igneous Layering* will prove a worthwhile addition to the personal library of anyone, from field geologist to fluid dynamicist, interested in layered intrusions.

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FELDSPAR MINERALS, vol. 1. By J. V. Smith and W. L. Brown. Springer-Verlag, New York, 1988. 828 pages, $210.00.

This revised and extended second edition of *Feldspar Minerals* by J. V. Smith and W. L. Brown will be welcomed by mineralogists and petrologists for whom feldspars form a primary or secondary research interest. The contents of volumes 1 and 2 of the first edition by J. V. Smith, published in 1974, have been condensed and updated in this new volume 1, which deals with "Physical, chemical, and microstructural properties." A new volume 2, corresponding to the original volume 3 on petrology, phase relations, and occurrences of feldspars, as originally planned by J. V. Smith, is promised with I. Parsons as an additional author. As in the first edition, the authors have attempted to provide a comprehensive and detailed review of the properties of feldspars. Readers who are not familiar with the general background on the behavior of feldspars in nature might be advised to turn first to the more pedagogical *Feldspar Mineralogy* (Mineralogical Society of America Reviews in Mineralogy, vol. 2, 1983, P. H. Ribbe, Ed.). The present book covers a wider range of topics in much greater depth, however, and will be an invaluable guide to what is now known about natural and synthetic feldspars.

The book is divided into four principal sections. In part 1, "Crystal structures," the elements of feldspar structures are described. Five separate chapters deal with the essential crystallography and extend to detailed models of the different ordered structures. In part 2, "Physical properties and experimental techniques" are outlined, with eight chapters reviewing information from diffraction, optical, electron-optical, spectroscopic, thermal, electrical, and mechanical studies. This section will be useful, not only for its descriptions of the experimental techniques, but also for the large amount of data painstakingly assembled in figures and tables. Part 3 deals with "Chemical properties and experimental techniques" and sets out the major-, minor-, and trace-element chemistry of feldspars at length. Part 4 contains six chapters on "Diffusion, growth, twins, and intergrowths." Again, extensive tables and figures contain collated data, such as diffusion rates, nucleation rates, and viscosities in the liquid state. Long, but instructive reviews of zoning patterns, twinning, and exsolution mechanisms are followed by descriptions of feldspar intergrowths with other minerals. Almost 140 pages of densely packed references then provide as complete a bibliography of feldspar literature (up to 1987) as is available anywhere.

The whole book has been beautifully produced. High-quality optical and electron-optical micrographs provide good examples of most of the microstructural or textural features likely to be found in natural feldspars. The line drawings are also on a lavish scale, and although some of the graphs and diagrams seem a little cluttered with data, this is presumably the price to be paid for attempting to be comprehensive. As with the first edition, there are three indexes—an author index, a geographical index, and a subject index—that provide ready access to the text, figures, and tables. It is as easy to check what is known about a given feldspar from a locality of interest as it is to follow up the views of different authors, for example.

Just as no two feldspars ever quite seem to behave in an identical manner, it is rare to find two authors who agree on all aspects of feldspar mineralogy. As a consequence, the book contains a few obvious quirks, such as two separate and not entirely consistent systems of nomenclature. In addition, in places it is left to the reader to assess the validity of several conflicting points of view. For example, three alternative versions of the subsolidus phase relations of the plagioclase feldspars and two of the alkali feldspars are given. The thermodynamic arguments that might usefully have been brought in to discriminate between these are left to volume 2. Presumably all the thermodynamic data for feldspars will be included in the second volume, along with phase diagrams and occurrences in nature. Such quibbles only reflect the prejudices of a third party (i.e., the present reviewer), however, and do not detract from the substantial achievement of the authors in producing such an extensive review both of factual information on the physical and chemical properties of feldspars and of the different models and hypotheses that abound in the feldspar literature.

Feldspar Mineralogy, volume 1, is an essential addition to any library attempting to keep abreast of current developments in mineralogy and petrology. Regrettably, at a horrifying cost of $210 it is unlikely to appear on the private shelves of many academics. Only those of us fortunate enough to receive review copies will probably be able to have this compendium of information close at hand for easy day-to-day reference. Volume 2, when it appears, will be equally welcome!

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Eh-pH DIAGRAMS FOR GEOCHEMISTRY. By Douglas G. Brookins. Springer-Verlag, Berlin, 1988. 176 pages, $89.50.

This hard-cover book is a collection of 98 Eh-pH diagrams, representing 75 elements. The diagrams for each element are accompanied by a corresponding table of thermodynamic data

and a brief discussion. The pages are printed on a rather heavy, low-gloss paper. The price is a disgraceful $89.50, representing a cost of nearly 51¢ per page. (This reviewer was curious as to how the cost of 51¢ per page might compare to the value of precious metals. By removing and weighing a page, it was found that each page weighs about 2.8 g, or roughly 0.09 troy ounce. This means that the cost of each page in this book is about 85% of an equal weight of pure silver at the current price of about $6.60 per ounce.)

The diagrams are constructed only for 25 °C and 1-bar pressure. A single diagram is presented for most of the elements, but multiple diagrams are given for As, Sn, Cu, Au, Ni, Fe, Mn, Tc, Re, Am, Pu, Np, and U. To the best of this reviewer's knowledge, several of the diagrams are new and have not been presented previously in the literature. Reactive ligands (from added S, C, Si, etc.) are considered in many of the diagrams, but no explanation is given as to why the particular activities (10^{-3}, $10^{-2.5}$, etc.) of the ligands were chosen.

The diagrams are presented in "the standard order of arrangement of the elements," but without adequate explanation of the logic of this arrangement. For further explanation of the sequence of diagrams the author refers the reader to Figure 1 in Wagman et al. (1982) (Wagman, D. D., Evans, W. H., Parker, V. B., Schumm, R. H., Halow, I., Bailey, S. M., Churney, K. L., and Nuttall, R. L., 1982, *The NBS Tables of Chemical Thermodynamic Properties: Selected Values for Inorganic and C_1 and C_2 Organic Substances in SI Units:* Journal of Physical and Chemical Reference Data, vol. 11, Supplement no. 2, 392 p.). Unfortunately, this "standard" arrangement will require readers who have not memorized the periodioc table to constantly refer to the Table of Contents to locate any particular diagram of interest. It would have been much more helpful for students (if any can afford the book) and for many researchers had the author chosen to present the diagrams in alphabetical order, or in sequence of atomic number or atomic weight.

Most of the thermodynamic data for the diagrams are taken from the National Bureau of Standards compilation of internally consistent data by Wagman et al. (1982). Miscellaneous data from other sources are also included, but the author did not follow the calculational methods suggested by Wagman et al. (1982) to make the data internally consistent. The data are presented in the old units of kcal/mol, instead of the preferred kJ/mol. The diagrams for the REEs, Pu, Np, and U generally use selected thermodynamic data from the Organization for European Cooperation and Development and thus may be reliably used by researchers in the field of disposal of nuclear waste.

The diagrams are presented in a variety of styles of lettering and widths of lines, giving the impression that the book has been "glued together," either from different sources or over a long period of time. This is clearly the fault of the publisher, not the author. The publisher no doubt required the author to submit camera-ready diagrams. However, for a price of $89.50, one would think that the publisher would feel some slight obligation to have the diagrams redrafted into a uniform and consistent style.

A great many typographical errors are present. They begin in the preface of the book (on p. V, for example, "valance" appears instead of "valence" and "never" instead of "newer") and are scattered throughout the remainder of the book. Several garbled sentences are also present. For example, the footnote on page 7 states that "The exact budget of different carbonic acid species must be calculated if (pH) to rigorously solve this equation." On page 8 one reads that "To calculate the Eh-pH diagrams for any other temperature, but still at 1 bar, pressure is straightforward." On page 52, one finds "Tl_2S appears above pH = 7.9 for a Tl activity of 10^{-6}, and at pH for 10^{8}." For a cost of $89.50, one would think that the publisher would have felt an obligation to assign an editor to proof the manuscript.

This reviewer did not immediately recognize any obvious errors in the diagrams themselves. However, there are some surprising omissions. For example, on page 28 the author discusses the importance of scorodite (iron arsenate) in the behavior of As, but he does not include scorodite on the diagram. Similarly, on page 38 the importance of GeS_2 is described, but it is not shown on the Ge diagram. In the section on Fe, six diagrams are presented, but the only silicate of Fe shown on the diagrams is the unrealistic $FeSiO_3$; this is the same compound that Latimer used in his book back in 1952. Figure 43 shows a large field of stability for $Pd(OH)_{2(s)}$, but no data are given for that compound in the table of free energies. These omissions lessen the value of the diagrams and force one to be just a bit cautious in using them.

So, is the book useful? Yet, it is. It is the type of book that all libraries and most professional geochemists will be required to buy, and the exorbitant price put on the book by Springer-Verlag may reflect that fact. Readers will probably not find the exact diagrams needed for any particular geochemical problem, but general guidance is presented for most elements of geochemical importance. In this sense it is similar to the collection of diagrams constructed by students of R. M. Garrels, compiled and published by Schmitt (Schmitt, H. H., Ed., 1962, *Equilibrium Diagrams for Minerals at Low Temperature and Pressure,* Geological Club of Harvard, Cambridge, Massachusetts, 199 p.). The book will not be helpful for students who are just beginning to work in geochemistry because the diagrams are too generic and the introductory text is too brief and confusing to be of value to students. However, it would certainly be appropriate for a professor to buy the book and to loan it out to students who need a first-look at the general behavior of particular elements. Brookins deserves our thanks for being willing to take on this tedious but meaningful task. It is too bad that Springer-Verlag failed so completely to support Brookins in producing a polished final product at a reasonable price.

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