BOOK REVIEWS

THE SYSTEM OF MINERALOGY OF JAMES DWIGHT DANA AND EDWARD SALISBURY DANA, Yale University, 1837–1892; seventh edition, entirely rewritten and greatly enlarged, by CHARLES PALACHE, HARRY BERMAN, AND CLIFFORD FRONDEL, Harvard University; Volume II, halides, carbonates, nitrates, iodates, borates, sulfates, selenates, tellurates, chromates, phosphates, arsenates, vanadates, antimonates, vanadium oxysalts, molybdates, tungstates and organic compounds. New York (John Wiley and Sons), London (Chapman and Hall) 1951, xi+1124 pages, many figures $6\frac{1}{4}\times9\frac{1}{4}$ inches. Price, $15.00.

It is a pleasure to note the appearance of the second volume of the work that has dominated American mineralogy for well over one hundred years and has been very prominent among mineralogical works the world over during much of this time.

In his excellent review of Volume I, Peacock (*Am. Mineral.*, **29**, 453–454, 1944) discusses most of the ways in which the Seventh Edition differs from and extends the scope of the Sixth. There is no point to repeating this discussion, and not a great deal could be added to it. However, Peacock did not mention that the new edition includes optical properties of opaque minerals. This is a big step forward; it will greatly increase the usefulness of the work and will be welcomed by all mineralogists.

The new edition will no doubt maintain the position of its predecessor. The amount of compilation, original work, and editorial effort that has gone into this revision is almost beyond comprehension, especially when it is realized that the brunt of the preparation of Volume II has been borne by a single individual.

The reviewer regards this tremendous undertaking with a certain amount of awe, but he cannot agree with Spencer (*Min. Abs.*, **11**, 463, 1952) that "Criticism . . . would be . . . sacrilegious." Any work of this magnitude must treat of subjects on which there are legitimate differences of opinion and must be subject to improvement in the manner of presentation of some of the material. Attention is respectfully called, therefore, to several topics and usages that might be handled somewhat differently to good advantage.

For example, substitution of nO, nE, nX, nY, and nZ for ω, ϵ, α, β, and γ to indicate indices of refraction goes from a simple to a much more complex and potentially ambiguous system. The Greek letters have long been used in this connection and their meaning is clear and unmistakable. They are in widespread use in the analytical expressions of the theory of crystal optics. In many of these equations the letters X, Y, and Z are used as space co-ordinates. A glance at such equations in Johannsen's Manual of Petrographic Methods, Wahlstrom's Optical Crystallography, the works of F. E. Wright, or similar treatments will show that the use of α, β, and γ for indices of refraction is much more pleasing and less confusing than substitution of nX, nY, and nZ would be. For example, the well-known equation

$$\frac{X^2}{\alpha^2}+\frac{Y^2}{\beta^2}+\frac{Z^2}{\gamma^2}=1$$

becomes

$$\frac{X^2}{nX^2}+\frac{Y^2}{nY^2}+\frac{Z^2}{nZ^2}=1$$

and derivations from this and related equations are even more complicated and confusing. It would be much simpler and more logical to continue to use ω, ϵ, α, β, γ and X, Y, Z with their classical meanings of indices of refraction and space co-ordinates, respectively, than to attempt to change either or both usages.

It is unfortunate that changes were made in the letters used to designate the various forms of calcite. Admittedly, the system proposed by Goldschmidt in 1886 has priority over the usage of Dana. However, the letters used in the Sixth Edition have been so widely employed during the past thirty years in studies of calcite-bearing tectonites and of artificial deformation of marbles that great confusion would result now by a change, for example, to δ instead of e to represent $\{01\bar{1}2\}$ or to p instead of r to represent $\{10\bar{1}1\}$. Moreover, the new edition does not follow the older scheme exclusively; it retains $c\{0001\}$ and $m\{10\bar{1}0\}$, whereas Goldschmidt used o and b for these forms. Also, the new edition employs $e\{01\bar{1}2\}$, $r\{10\bar{1}0\}$, $v\{21\bar{3}1\}$, etc., for the other rhombohedral carbonates, so the usage is not consistent in any respect.

The handling of literature references could have been improved in several ways. In the Sixth Edition the references were given together with the information taken therefrom; in the Seventh Edition the references are given in lists at the end of the description of each species, and it is commonly necessary to turn several pages to find a reference. There is no easy way to find out whether a given citation (except those later than 1915) or an analysis is repeated from the earlier edition; some analyses are repeated in the same form; some are reported in different components so that they must be recalculated to be sure whether they are the same analyses or different ones taken from the same reference. A simple indication such as an asterisk for each analysis new to this edition would greatly simplify reference for the reader.

In Volume I, a complete bibliography was given, including periodicals with their respective abbreviations and other pertinent data, and a list of books consulted. The more than seven years that intervened before Volume II appeared were marked by many changes in mineralogical literature; new books have appeared; new journals, such as the *Heidelberger Beiträge, Geochimica et Cosmochimica Acta*, and *Acta Crystallographica* have been established; major changes have taken place in some publications, e.g., in the *Neues Jahrbuch;* and other publications have been discontinued. No mention is made of these changes in Volume II; perhaps the bibliography can be brought up to date when Volume III is published.

In the preface to Volume I, emphasis is placed on "a new method of treating minerals that form a so-called series." This new method is also followed in Volume II but leaves a great deal to be desired. There is not a single diagram representing the properties of a mineral series in either volume; for the most part, properties are not correlated with the analyses given. Properties (indices of refraction) are commonly given for only one intermediate composition, so that one must interpolate for other compositions, and the interpolation is not accurate if the property is not a straight-line function.

All the crystal drawings have been redrawn and are, for the most part, larger than the figures in the older edition. Correlation with the discussion in the text, however, is much more difficult than it was in the previous edition. This is partly because the figures are not numbered and partly because references in the text are to form symbols, whereas the faces on the drawings of crystals are designated by letters.

Several examples of nomenclature might be questioned; one glaring case to which attention should be called is the relegation of the well-established name *martinite* to the synonymy and the substitution therefor of *whitlockite*.

Typographical errors are more numerous than in the Sixth Edition but are neither serious enough to call for a listing nor abundant enough to be noticeable in ordinary reading or reference. With a work of this magnitude that has been so completely rewritten and has had so much and so many kinds of new material added, the surprising thing is that there are not more errors, inconsistencies, and oversights.

Professor Frondel, who is very largely responsible for the preparation of Volume II, is to

be heartily congratulated on its appearance and on the fact that it maintains the high standard set by Volume I and by the magnificent Sixth Edition. Volume III, the Silicates, which will complete the monumental Seventh Edition, is eagerly awaited.

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A THOUSAND AND ONE QUESTIONS ON CRYSTALLOGRAPHIC PROBLEMS, by P. TERPSTRA. Publication from the Crystallographic Institute of the University of Groningen. J. B. Wolters, Groningen, Djakarta. 195 pp., 183 figs., 1952. Paper bound.

The author has prepared a collection of problems covering an impressive range of crystallographic subjects. He states that the book is intended for use by "junior students," —our own impression is that anyone who could answer all these questions would be a well-rounded crystallographer indeed. A teacher looking for classroom exercises will spend many a stimulating evening browsing through these miscellanea. He will find that some of the problems are not easy; that others take time. The latter are more in the nature of seminar topics. For example, Problem No. 4 on page 111 is stated as follows: "Data: An edge of a crystallographic polyhedron can be seen (1) as the line of intersection of two faces; (2) as the axis of a zone; (3) as the line connecting two coigns of the polyhedron. Questions: (*a*) Study methods for the construction of crystallographic drawings in the following books and articles: A. E. H. Tutton . . . , M. Reeks . . . , A. Nies . . . , R. L. Parker . . . , M. W. Porter . . . , C. Viola . . . , L. Weber . . . , L. Burmester . . . , P. Terpstra . . . (*b*) Divide after the above quoted characteristics these methods in three groups." The answers to the questions are not given; we wish the author would publish them in a companion pamphlet.

The Table of Contents is missing. If there were one it would read as follows (number of pages in each chapter given in parentheses): I. Miller indices in the rhombohedral system (4), II. Geometrical crystallography (34), III. Rhombic section (4), IV. Transformation of co-ordinates (7), V. Twinning (10), VI. Gliding (23), VII. Lattices (20), VIII. Crystal drawing (8), IX. Optics (29), X. Laue patterns; Space groups; Weissenberg patterns (41), XI. Structure factors and Fourier series (8). A two-page index refers to subjects and to authors.

The order in which the chapters are arranged is somewhat puzzling, but their relative lengths seem well suited to give the student a thorough foundation in morphology and optics, and bring him up to structural crystallography.

After four books in Dutch, Professor Terpstra has decided to write this one in English. The going is rough in spots, but his readers will gladly grant him the leniency for which he begs in the preface. Long passages are quoted in either French or German; a Latin motto and its Dutch translation, on the last page, give a final polyglot touch. The "1001" questions are not numbered, we did not count them, but we bet you there are more!

DONNAY AND DONNAY

FOURIERSYNTHESE VON KRISTALLEN UND IHRE ANWENDUNG IN DER CHEMIE, by W. NOWACKI. 238+13 pp., 120 figs., and 28 tables. Verlag Birkhäuser, Basel. Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, Chemische Reihe, Band VI, 1952. Cloth bound. Price Sw. Fr. 34.30 ($8.00).

This is the first comprehensive account of Fourier methods in structural crystallography. The author is professor of crystallography at the University of Bern, Switzerland. That such a monograph should appear in German is not surprising since the methods have been described almost exclusively in English publications—it does fill a special need for German workers. The foremost impression which the American reader receives is that of a

well organized and thorough literature survey. It includes most papers up to 1948 and a few 1949 titles.

The first part is theoretical. It begins with Fourier series whose coefficients are structure factors, F. Electron-density sections as well as projections are treated. Here, as throughout the book, numerical examples from the literature are given in detail. Then follow discussions of accuracy of parameters, refinement methods, conversion of the data to an absolute scale, and phase determination. The second chapter covers $|F|^2$-syntheses of all kinds. The second part is practical. It deals with calculating aids: strips, punched-card machines, mechanical and other analogue computers. Special sections are devoted to optical methods of synthesis and the abortive attempt to use microwaves. Three alphabetical indexes are appended: authors, subject matters, and substances mentioned. Extinction tables appear in a separate, paper-bound, supplement; they list the presence criteria and the space groups corresponding to Buerger's 120 diffraction symbols (no alternate orientations are given).

As a textbook for advanced students, the treatment is not quite thorough enough. A considerable number of derivations are given, but many stumbling blocks are passed over, and such statements as "es ist anschaulich klar" and "es lässt sich leicht zeigen" abound. Before he can intelligently apply the methods described, a student will still have to study the literature. Excellent bibliographies, given at the beginning of each section, will make this easy for him. They will also help scientists in neighboring fields, who might wish to embark on a crystal-structure determination. For such readers, however, a critical appraisal of the methods presented would have been desirable.

Here are a few minor comments. Following an infelicitous British practice, Nowacki reserves the name "Fourier syntheses" to F-summations and uses other designations for $|F|^2$-summations, even though they too are Fourier series. Contrary to custom he advocates (p. 13) using "structure amplitude" for F and "structure factor" for $|F|^2$. His "ideal Realkristall" is our ideally imperfect crystal. The language is on the whole encouragingly simple and clear. Three recurring abbreviations baffled the reviewer, who begs to offer her interpretations: *u.W.* = unseres Wissens, so far as we know; *u.U.* = unter Umständen, under certain circumstances; *m.a.W.* = mit anderen Worten, in other words. The book has been reviewed by F. A. Bannister (*Min. Abs.* **11**, 513, Sept. 1952), and by D. P. Shoemaker (*Acta Cryst.*, **6**, 224, Feb. 1953).

Crystallographers will be indebted to the author for his useful compilation. All will share the hope that this volume can be kept up to date in future editions.

GABRIELLE DONNAY

ERZMIKROSKOPISCHES PRAKTIKUM, by HANS SCHNEIDERHÖHN. E. Schweizbart'sche Verlagsbuchhandlung (Erwin Nägele), Stuttgart. 1952. Price (bound in linen) DM 40.60.

This work of Professor Schneiderhöhn is essentially a new edition of the *Lehrbuch der Erzmikroskopie*, Vol. 1, Pt. I (Gebrüder Borntraeger) 1934, by Schneiderhöhn and Ramdohr. It will be remembered, perhaps, that the first part of this important "Lehrbuch" was largely the work of Schneiderhöhn. He has now revised it to include the new advances since 1934. The changes in the book are largely elimination and simplification. The section on microchemical analysis has been eliminated, and those regarding spectroscopical and x-ray examinations much reduced. The long and rather theoretical discussion by Doris Korn on the determination of the optical orientation of an opaque mineral in a polished section in the original volume has also been dropped. Otherwise the new book is little changed, even as to its wording.

Two chapters are new: Observations on Individual Minerals; and The Structure of

Aggregates. In the first named chapter general remarks are included concerning such topics as grain shape and size, twinning, zonal structure, intergrowths, exsolution structures, etc.; in the second, general descriptions of the various types of structures encountered in ore-mineral aggregates.

The text is supplemented by 32 plates with 64 figures of beautifully photographed and reproduced photomicrographs, most of which are new. A bibliography of 262 titles combines all the titles referred to in the text. A separate section of determinative tables occupies a pocket at the end of the volume. These tables include a determinative one of 3 pages, based upon the reflection capacity as measured by the microphotometer, and a second of 20 pages of the individual ore minerals, arranged alphabetically, giving the pertinent diagnostic optical, physical and x-ray data for 189 minerals.

This new work brings the highly useful Part I of the *Lehrbuch der Erzmikroskopie* up to date. Part II has already been revised by Ramdohr as *Die Erzmineralien und ihre Verwachsungen* (Akademie Verlag, Berlin. 1950). The printing and paper are good and the German text clear and easily comprehensible for the American reader. The binding, however, is flimsy for a book that will be submitted to frequent use, and the book and cover seem destined to part early in its life. This was done, perhaps, in an attempt to reduce the cost of the book to meet the constant complaint that scientific books and periodicals now printed in Germany are too high priced for many purchasers. The cost will certainly be a deterrent to its acquisition to many students, to which this work is especially directed. Nevertheless, the fact that there is no suitable substitute for this essential work should give it a wide market.

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DANA'S MANUAL OF MINERALOGY, sixteenth edition by Cornelius S. Hurlbut, Jr., viii+530 pp., 471 figures, XXII plates, frontispiece in color.

This sixteenth edition of *Dana's Manual of Mineralogy* is the second revision made by Professor Hurlbut and represents a far less sweeping revision than the first. The purpose of the revision seems to have been twofold: to bring the Manual abreast of developments in the field; to make the Manual pedagogically more sound. Both purposes have been achieved; the first by the addition of new data, the second by addition to and amendment of certain abstruse passages of the fifteenth edition. The new format is no particular improvement but is attractive and readable.

A new section on the *History of Mineralogy* has been added. In one section of this *History* Hurlbut states:

"During the latter part of the nineteenth century, mineralogy, for want of a tool sensitive and powerful enough to explore the fine structure of matter and affirm or deny the existence of Haüy's integral molecules, entered upon an unproductive period. . . . The situation was finally resolved in 1912 when x-rays . . . were demonstrated by Max von Laue to be the tool that would unlock the secrets of the crystal."

This sort of statement which labels the excellent and necessary descriptive work of the nineteenth and early twentieth centuries as *unproductive* is typical of the attitude of too many mineralogists today. If we examine Dr. Hurlbut's Manual we find that at least 90% of it could have been written prior to the twentieth century, and justly so. The advances of crystal chemistry have not negated the fact that mineralogy, as a subject, remains a natural science for the most part.

Professor Hurlbut has expanded his one page introduction of the fifteenth edition into a pedagogically improved seven pages entitled the *Nature of Minerals*. He has chosen in this edition not to define a *mineral* rigorously. (No mention is made of the fact that miner-

als are defined on the basis of their physical properties as well as their chemical properties.) He apparently now believes it is pedagogically better to derive concepts than to state them and explain them. From this reviewer's experience the other approach, which Hurlbut used in the fifteenth edition, has proved more satisfactory, in general.

Five pages are devoted to the new subject of *Applications of Mineralogy*, apparently to convince the student that the subject on which he is embarking is of adequate importance.

The new section on *Crystal Chemistry* represents the greatest departure from the fifteenth edition. Fourteen pages are devoted to such subjects as: *relation of chemistry to crystallography, polymorphism, structure, ionic bonds, covalent bond, van der Waal's bond, metallic bond, atomic packing, isomorphism, isostructure, exsolution, and homeomorphism.* Although the section is very clearly and very well written, the reader of the text is faced with the unhappy realization that there is very little application of the newly won principles in the other section of the book which is devoted to the treatment of individual minerals.

Another important and desirable difference between the fifteenth and sixteenth editions is the adoption in the latter of the Groth-Koksharow form nomenclature. Such terms as *macro, brachy, ortho, clino* have been deleted. Dr. Hurlbut has not seen fit to completely adopt the Groth Koksharow nomenclature but the exceptions have some pedagogical virtue.

A page is devoted to the meaning of the Hermann-Mauguin symmetry symbols, but no pedagogic use is made of them in the section on crystallography. They are not only good to know about; they are good to use as tools in the better understanding of crystal symmetries. On page 29, item 5 the positions of the symmetry elements for $\bar{6}m2$ are incorrectly stated. Crystal systems are defined in this revision on the basis of symmetry, rather than on relative lengths and angular relations of the axes.

The relative importance of the various mineral species is indicated in the text by the case of letters.

It is not possible to list here all of the new data which are included in the mineral descriptions. A few, however, will serve to demonstrate the painstaking care Dr. Hurlbut put into the revision of mineral descriptions, where necessary:

p. 210 Skutterudite replaces smaltite as a mineral name.
p. 230 New locality for emery; enlarged discussion on synthesis of corundum.
p. 261 New localities for mining of fluorite; mentions new use of optical fluorite.
p. 286 Places sulfates and chromates before instead of after phosphates *et al.*
p. 301 Adds (OH) to chemical formula of apatite.
p. 307 Corrects turquoise formula.
p. 309 Includes carnotite, which was not in fifteenth edition, but does not include it in mineral index in the rear of text.
p. 314 Enlarges bases for classification of silicates and gives figures as illustrations of each of the six silicate structural types. It is unfortunate that these structural type headings are not introduced into the proper places in the text of the actual descriptions of silicate species.
p. 374 Reassessment and restatement of occurrence of tourmaline.
p. 379 Lawsonite has been added, just why, it is hard to say.
p. 412 The beryl crystal from Albany, Maine, has apparently grown since the fifteenth edition.
p. 431 and following pages. More recent production and uses data for various substances.

In a completely reset text of this sort some typesetting errors will necessarily escape all proofreaders. A few of these plus some text errors plus some comments on sections of the text follow:

p. 8 Separates crystallography from physical mineralogy, but it is certainly a physical property.

p. 10 In the enlargement of various sections of the introduction, there has been little expansion of the *occurrence* of minerals under *descriptive* mineralogy. In a natural science such as mineralogy more attention to occurrence should be given in these introductory remarks. Parts of the discussion on pages 13, 14, and 15 belong under this heading.

p. 11 Not all *economic geologists* concentrate in the *ore minerals*.

p. 17 The new definition of cryptocrystalline is an improvement.

p. 18 Describes magmas as melts, rather than solutions.

p. 123 *Polar solvents* needs explanation or should be eliminated.

p. 124 The *middle* of the periodic table means nothing here. It is actually confusing, particularly since there are so many periodic tables extant.

p. 125 Line 3. "*Since tetrahedral groups, the basic units of structure*" should indicate that they are *basic for silicates*.

p. 129 Line 22. "It is becoming . . . clear that the unit of description (should often be, not *is*, reviewer) the mineral series."

p. 132 *This process of segregation and growth of rejected ions into autonomous crystal domains in the solid state from a disordered non equilibrium crystal is called exsolution.* What a sentence!

p. 250 Shouldn't limonite be placed in a category of a mixture as is bauxite?

p. 378 No mention of the recent great demand for beryl.

p. 401 There is nothing in the word *igneous* which implies a fluid origin. No mention is made of the fact that the formation of magmas is a subsurface phenomenon.

p. 402 No mention is made of the very important effect of volatiles on the texture of igneous rocks.

p. 414 Breccia and tillite should be mentioned. Marine conglomerates are ignored.

p. 415 No mention of flint or chert. The latter is certainly of considerable volumetric importance.

The above corrections and suggestions in no way detract from the over-all continued usefulness of this Manual as a textbook of mineralogy where it ranks, without question, amongst the most usable and pedagogically valuable books of its kind.

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TRANSACTIONS OF THE EDINBURGH GEOLOGICAL SOCIETY, Vol. XV, Campbell Volume. 408 pp. ed. by Arthur Holmes. 1942, 30s ($4.35).

This issue of the *Transactions of the Edinburgh Geological Society* is dedicated to Dr. Robert Campbell, who retired in September, 1951, after 47 years of devoted service as a teacher of mineralogy, petrology and geology, as a researcher, and as an administrator. The contributions by his students, associates and friends number 27 and are mainly in petrology, but papers on paleontology, glaciology, geochemistry, tectonics and geological education also are included. Many of the petrological papers deal with occurrences in Scotland. A high standard of quality is maintained throughout.

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