BOOK REVIEWS

PHYSICS AND CHEMISTRY OF THE EARTH. Vol. I, 317 pp. (1956), 55 shillings; Vol. II, 259 pp. (1957), $10.00. Pergamon Press, London and New York.

These volumes are the first of a series to be published annually. The foreword states, "The principal aim . . . will be to provide authoritative and up-to-date surveys of progress for those actively engaged in geophysics and geochemistry. But it is to be hoped also that much of what is written will encourage the interest of the chemist and physicist in a study of our planet, not merely for its own sake, but because such a study often turns out to be of benefit to physics and chemistry. Another aim is to acquaint the geologist with the results and methods of geophysics and geochemistry, particularly as progress in earth science has been hindered by some lack of liaison between different groups."

The contents of the two volumes are:

Volume I

The origin of the solar system. Sir Harold Spencer Jones, pages 1–16.
Temperatures within the earth. J. Verhoogen, pages 17–43.
Radioactive methods for determining geological age. L. H. Ahrens, pages 44–67.
Seismology and the broad structure of the earth's interior. K. E. Bullen, pages 68–83.
The hydrodynamics of the earth's core. Raymond Hide, pages 94–137.
Investigations under hydrothermal conditions. Rustum Roy and O. F. Tuttle, pages 138–180.
The geochemistry of the halogens. Carl W. Correns, pages 181–233.
Geochemistry in the U.S.S.R. (1948–1953). S. I. Tomkeieff, pages 235–284.

Volume II

An experimental approach to problems in physical oceanography. William S. von Arx, pages 1–29.
A survey of the quality of some of the principal abundance data of geochemistry. L. H. Ahrens, pages 30–45.
Boundary conditions for theories of the origin of the solar system. Harold C. Urey, pages 46–76.
Some current aspects of chemical oceanography. Francis A. Richards, pages 77–128.
Recent geophysical exploration of the ocean floor. M. N. Hill, pages 129–163.
The geochemistry of gallium, indium, thallium—a review. Denis M. Shaw, pages 164–211.
Latitude variation. P. J. Melchior, pages 212–243.

The board of editors, L. H. Ahrens, K. Rankama, and S. K. Runcorn for volume I, and the same plus Frank Press for volume II, have assembled two volumes that meet the aims set forth. Many of the articles are of evident interest to mineralogists; the unwary reader may find himself fascinated by a review of something outside his normal field of interest, as I was, for example, by the paper by von Arx. Both volumes are highly recommended.

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MANUAL OF THE POLARIZING MICROSCOPE, by A. F. HALLIMOND, reprint of the second edition of 1953 with additions and minor corrections. 219 pp., Cooke, Troughton and Simms, Ltd., York, England, 1956.

A detailed review of the second edition of this book appears in volume 39 of this *Journal* on pages 845–846. The 1956 reprint edition contains minor corrections and two new appendices. In preparing this reprint, some confusion is introduced into the numbering

of the figures. The figure on page 184 is unnumbered. Figure 93 is assigned to an illustration on page 190 and to another on page 202.

Appendix 5, entitled, "Preparation of Polished Sections," consists of six pages and one figure. It is a supplement to Chapter 18 and it takes into account the recent developments in polishing techniques which have improved the quality of the polished surface and reduced the time necessary to produce it. There is a detailed discussion of the use of norbide and sized diamond dust as abrasives, and of the use of nylon and other materials as surfaces for laps. Mention is also made of polished thin sections.

Appendix 6 treats the "Point Counter." The emphasis is on the I. H. Ford point counter. A curious error appears in this section where the Wentworth-Hunt instrument for thin section analysis is stated to be a variant of the Leitz, six-spindle stage described by K. H. Scheumann (1931). This arises from a reversal of the date of publication of Hunt's paper given as 1942. Professor Hunt's paper actually appeared in 1924.

Two color plates are a welcome addition to this book. They contain 18 colored figures, consisting of the spectrum, the spectrum of an interference color in a higher order, the quartz wedge, the quartz wedge in red light, pleochroism of penninite, 4 figures of thin sections, a quartz fragment between crossed polars, and six excellent interference figures.

Mineralogists, petrographers, economic geologists, and microscopists will find much of value to them in this book.

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THE DIFFERENTIAL THERMAL INVESTIGATION OF CLAYS. Edited by ROBERT C. MACKENZIE with contributions by twenty-two authors. 456+xii pp., 99 figures. Mineralogical Society, 41 Queen's Gate, South Kensington, London, S.W. 7, 1957. Price $9.00.

This book is the sequent volume to the monograph *X-Ray Identification and Crystal Structures of Clay Minerals* published by the Mineralogical Society. The title is somewhat misleading as to the scope of this book in that DTA (differential thermal analysis) curves and references to the literature are given for a fairly large number of non-clay group minerals. The book is well illustrated and although there are only 99 figures listed as such, almost every figure is made up of several parts or contains two or more thermal analysis curves. There are 26 TGA (thermogravimetric analysis) curves, 18 weight loss (or dehydration) curves, and about 410 complete, or reasonably complete, DTA curves.

The chapter titles and the authors are as follows:

I. Thermal Methods
by R. C. Mackenzie

II. Apparatus and Technique for Differential Thermal Analysis
by R. C. Mackenzie and B. D. Mitchell

III. Theory and Quantitative Use
by E. C. Sewell and D. B. Honeyborne

IV. The Kaolin Minerals (Kandites)
by D. A. Holdridge and F. Vaughan

V. The Montmorillonite Minerals (Smectites)
by R. Greene-Kelly

VI. The Mica Minerals
by M. Munoz Taboadela and V. Aleixandre Ferrandis

VII. The Vermiculite Minerals
by G. F. Walker and W. F. Cole

VIII. The Chlorite and Serpentine Minerals
by S. Caillere and S. Henin

IX. The Sepiolite and Palygorskite Minerals
by S. Caillere and S. Henin
X. Clay Mineral Mixtures and Interstratified Minerals
by W. F. Cole and J. S. Hosking
XI. The Silica Minerals
by R. W. Grimshaw and A. L. Roberts
XII. The Oxides of Iron, Aluminum and Manganese
by R. C. Mackenzie
XIII. The Carbonate Minerals (with some notes on calcium and magnesium hydroxides)
by T. L. Webb and H. Heystek
XIV. Other Minerals
by R. J. W. McLaughlin
XV. Differential Thermal Analysis using Controlled Atmosphere
by E. C. Jonas and R. E. Grim
XVI. Carbonaceous Materials
by R. W. Grimshaw and A. L. Roberts
XVII. Practical Applications
by R. H. S. Robertson

Seventy-nine pages of the book, chapters I, II, and XV, are devoted to the history, apparatus, limitations, and interpretation of DTA methods per se. Some information is also given for TGA and other methods of thermal analysis. The theory of DTA and of the quantitative methods is discussed in thirty-three pages. The rest of the book deals with the DTA, and to a lesser extent TGA, and dehydration curves of minerals and carbonaceous materials. The differential thermal analysis of the clay minerals is treated in great detail and special techniques and methods of interpretation of the data are given. The nomenclature of the clay minerals in this book is not satisfactory.

The book is well documented with references, including those to the Slavic literature. It is a mine of information and all workers in thermal analysis will be grateful to the authors and the editor for their efforts. *The Differential Thermal Investigation of Clays* deserves the attention of all students in this field.

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LABORATORY MANUAL OF CRYSTALLOGRAPHY FOR STUDENTS OF MINEROLOGY AND GEOLOGY, by GEORGE TUNELL AND JOSEPH MURDOCH. Wm. C. Brown Company, Dubuque, Iowa, 1957; lithoprinted, in paper covers, 55+v pages. A 14 cm. stereographic net is included in a pocket.

The *Laboratory Manual of Crystallography for Students of Mineralogy and Geology* is intended to supplement the standard textbooks in mineralogy, containing a more thorough treatment of geometrical crystallography than is usually given.

In the first chapter of the manual, the concept of vector properties of crystals as related to symmetry is introduced. Elements of symmetry, including axes of rotary reflection, are described. The equivalence of symmetry elements is schematically shown.

The following four chapters contain a description of the use of the contact goniometer; definition of zones; treatment of the law of rational intercept ratios, Miller indices, and zone indices; and a brief explanation of the stereographic projection and crystal classes and systems.

Chapter VII, "Crystal Forms in the 32 Crystal Classes," follows, for the most part, the logical nomenclature of Federov and Groth as modified by Rogers. A number of alternative form names are given in the tabulation, for example, monohedron for pedion. The authors seem to prefer the term dihedron for both the dome and sphenoid, although

the alternative terms are given. To the reviewer this seems an unfortunate choice. Form names are given for the seven types of Miller indices for each of the crystal classes. Table 8 in Chapter VIII, "Summary of the 32 Crystal Classes," gives a stereographic and axonometric projection (orthographic on an inclined plane) of the general form for each class. A notable feature of these illustrations is that the stereographic projection truly represents the specific general form illustrated. The crystallographic elements, direct and polar, including those fixed by symmetry, are listed. The choice of reference axes with respect to symmetry is indicated. The indices of all of the faces of the general forms are given, including those for alternate settings.

The calculation of axial angles is described in Chapter IX. In this chapter the use of the gnomonic projection and polar lattice are introduced as an aid to indexing crystals. The use of crystallographic data in relation to other properties of minerals, as applied to mineral identification, is explained in the last chapter.

The appendix is a list of minerals arranged alphabetically under crystal class and system. Crystals whose classes have not been determined uniquely are appropriately indicated. For each system a list of minerals—undifferentiated with respect to class—is included.

The detailed summaries in Chapters VII and VIII constitute a valuable recapitulation of the geometrical features of the 32 crystal classes. The manual should be useful in teaching elementary crystallography to undergraduate students of mineralogy and geology.

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MINERALOGISCHE TABELLEN, Eine Klassifizierung der Mineralien auf kristallchemischer Grundlage, Dritte Auflage, by HUGO STRUNZ. 448+x pp., illustrated. Akademische Verlagsgesellschaft Geest & Portig K.-G., Leipzig, 1957. DM 34.– ($10.30).

The latest edition of this most useful work represents an increase in size of the volume by approximately one-half over the second edition, which appeared in 1949, despite the concise tabular arrangement of the data. A new and valuable addition in this revision is the index of formulas which comprises 19 pages. It now appears in a full cloth binding.

Strunz's "Mineralogische Tabellen" represents, in outline form, the composite information obtained through a crystal-chemical approach to mineralogy. How significant the progress in mineralogical science has been becomes apparent upon comparison of "Mineralogische Tabellen" by P. Groth and K. Mieleitner, published in 1921, with the present volume.

To the general discussion of crystallographic and crystal-chemical principles (part I) has been added a table of ionic radii of Goldschmidt, of Pauling, and of Ahrens. Although most of the figures are the same as those previously used, portions of the text have been completely rewritten.

The use of "klinovariscit" (metavariscite) and "klinostrengit" (phosphosiderite) is consistent with the dubious principle of changing names for the sake of making changes—an innovation introduced into "Dana's System of Mineralogy" by Frondel, except that the latter author uses "metastrengite," an even less justifiable synonym for phosphosiderite. Other criticisms seem superfluous.

This latest edition of this most outstanding summary treatment of crystal-chemical mineralogy deserves extensive utilization on the part of American mineralogists; Strunz's book falls in the "essential" category.

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X-RAY CRYSTAL STRUCTURE, by DAN MCLACHLAN, JR., pp. xiii+416. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1957. Price $15.00.

The purpose of this book is set forth in the opening sentences of its preface: "Many books have been written in a *popular* style to emphasize the importance of x-ray crystallography and to create interest in the wonderful findings of the workers in the field. A few books have been written with *rigor* for the benefit of the most advanced scholars. In between the extremes of *popular* and *rigorous* there is a gap. As a consequence of this gap, a very large proportion of the x-ray crystallographers actively engaged in the field in America today are working out structures successfully only because they have bridged the gap by having read a necessarily large number of those papers in the scientific journals which serve as signposts for the theory and the proper procedure. It is the purpose of the present text to furnish a common source in which the student may find condensed the teaching of the pioneers in crystallography."

This aim the author has sought to accomplish in nine chapters and an appendix. Every chapter is flavored by the author's own style and approach. This seems refreshing in places but the author is clearly an impatient man. Many subjects are barely touched upon and the reader is repeatedly advised to make a "study of the literature" or "urged to consult" original sources. If he follows these suggestions he will have to read a "necessarily large number of those papers.

The first chapter of 23 pages, entitled "Crystals," opens with a brief historical account in which crystallography up to 1912 is treated with more than the usual contempt which it meets in some circles. Not even Fedorov is mentioned. In this chapter one may read that "there are 230 space groups among crystals, all identifiable by the occurrence of absences or extinctions" and that "these 14 lattices are often called Bravais lattices because of his discovery of them by optical means." The point groups are enumerated in this chapter and each is illustrated by a stereographic diagram showing the distribution of planes of the general form and by a crystal drawing. Some of these drawings suggest that there has been a decline in the "art of pictorial representation" which is said to have been "well advanced" before 1912. The stereographic diagram for the point group $\bar{3}m$ shows only 6 points representing the general form.

The second chapter, "Point Groups and Space Groups" (53 pages), is largely devoted to the derivation of the point groups in an elegant manner. This leads to their description in terms of "functional symbols." These symbols are tabulated together with the Schoenflies and International symbols but both of the standard schemes of symbolism remain unexplained. The point groups are again shown in diagrams, this time in pictures of general sets of points in space groups having primitive lattices and no symmetry elements with translation components, from $P1$ to $Pm3m$ as it were. Only 12 pages are devoted to space groups, about half this space being occupied by a table. The legend of Fig. 2–9 reads "The transformation inferred by a mirror."

The third chapter, "Crystals and the Application of X-rays" (55 pages), includes descriptions of the principal methods for recording x-ray diffraction from single crystals. The emphasis does not correspond at all to the present importance of the several methods. Seven pages are devoted to "The Laue Camera and Gnomonic Projections." Fig. 3-26, which is intended to show the reciprocal-lattice interpretation of Laue diffraction patterns, is marred by faulty construction. The Schiebold-Sauter camera is allotted 4 pages, double the space given to the precession camera.

"The Determination of Space Groups" by x-ray diffraction is briefly and partially explained in the 19 pages of chapter 4. Extinction rules are set forth in a table, but since the structure factor equation has not been stated, their derivation is only vaguely hinted. No

mention is made of Laue groups, of the nature of the ambiguities that may arise, nor of the auxiliary data and considerations that may be involved in the determination of space groups. Over half of the chapter is occupied by two painfully detailed reports of student's exercises in space group determination.

In chapter 5, "The Scattering of X-rays" (44 pages), much space is devoted to basic concepts before the crucial matters of "structure factors of atoms" and "structure factors for crystals" are treated. Brief reference is made to "structure factors of molecules" and the chapter closes with a discussion of certain of the corrections to be considered in utilizing measured intensities. Chapter 6 (23 pages), on "The Nature and Properties of Fourier Series" lays the groundwork for the chapter which follows. All that the author has to say about crystal structure determination is contained in the 50 pages of chapter 7 on "The Phase Problem in Structure Determination." Though this may be considered the key problem of contemporary crystallography, the procedures of crystal structure determination are presented in a rather one-sided manner when discussed only as methods of solving this problem. Many crystal structures, even some intricate structures, have been solved by ingenious methods in which the phase problem was not explicitly involved. The chapter does contain a section on "the trial method" but hardly a suggestion is given of the many ways in which trial structures have been obtained. This is followed by sections on the use of heavy atoms and isomorphous pairs, the Patterson summation and means of its interpretation, and finally several sections on inequalities and other recent developments ending in 15 pages on the Karle-Hauptman method and its evaluation.

Chapter 8 (54 pages), on "Computing Aids in Structure Determination," begins with a discussion of the strip methods and continues with discussions of most, if not all, of the various optical, mechanical and electronic devices which have been used for facilitating crystallographic computation.

In the ninth and final chapter, 60 pages are devoted to "Examples of Structures Which Have Been Determined." The first two examples, those of TiN and tetraphenylmethane, are taken from student's theses. Equation (9-6) gives the structure factor formula for TiN, which has halite structure as $F_{hkl}=4(f_{\mathrm{Ti}}+f_{\mathrm{N}})$. Other structure determinations discussed are those of resorcinol, phthalocyanine, hexamethylene diamine dihydrochloride, trimethylamine sulfur trioxide and a hypothetical structure chosen to clarify the method of shifted Patterson products.

The appendix of 15 pages on "Special Recording Techniques" is devoted to "the gyrating Laue camera," "recording of x-ray diffraction patterns on spheres," the mechanical "transformation of Weissenberg pictures to undistorted theta lattices" and to "divergent beam pictures."

Throughout the style is highly personal and much emphasis is laid on curious or even trivial methods and devices which have caught the author's fancy. Though some sections are heavily weighted with mathematics, the brief section entitled "Stereographic projections" lacks exact statement of the derivation or properties of this projection and it is used solely for showing point group symmetry. It is to be expected that little space should be given in this book to diffraction by polycrystalline material, but it is surprising to find that little space devoted to the photographic recording of "Debye-Scherrer circles" on a sphere. It seems unlikely that this book will render obsolete the excellent British texts on the interpretation of x-ray diffraction photographs and the determination of crystal structures.

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STRUCTURE REPORTS FOR 1951. Vol. 15. General Editor A. J. C. Wilson; Section Editors: N. C. Baenziger (Metals), J. Wyart (Inorganic Compounds), J. Monteath Robertson (Organic Compounds). Published for the International Union of Crystallography. N. V. A. Oostheok's Uitgevers Mij., Utrecht, Holland. viii+588 pp. (1957). Price 110.—Dutch florins; £10.10.0; $29.00.

Those already familiar with these reports have eagerly awaited this volume. For those not familiar, it should be stated that they offer a very complete coverage of crystal structure data. These data are given in adequate detail, while non-structural portions of papers are not abstracted. Editorial comment, and in some cases corrections, are valuable features.

Volume 14, consisting of cumulative indices for 1940–1950, is now in preparation.

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SNOW CRYSTALS, NATURAL AND ARTIFICIAL, by UKICHIRO NAKAYA. 510 pages. Harvard University Press, Cambridge, Mass., 1954. Price, $10.00.

Dr. Nakaya, now Professor of Physics at Hokkaido University, has made a lifetime study of snow crystals, natural and artificial, having begun this fascinating study in 1932. This book is a summary of the work done by Professor Nakaya and his colleagues. Today they are able to produce every type of natural snow crystal in the laboratory and have determined, in almost every case, the conditions of their formation.

The book is divided into the following chapters:

Part I: Natural Snow
- Chapter 1. Observation of Snow Crystals
- Chapter 2. General Classification of Snow Crystals and Their Frequency of Occurrence
- Chapter 3. Physical Properties of Snow Crystals

Part II: Artificial Snow
- Chapter 4. Artificial Production of Frost Crystals
- Chapter 5. Artificial Production of Snow Crystals
- Chapter 6. Investigations on Artificial Snow
- Chapter 7. Comparison of Natural and Artificial Snow Crystals
- Chapter 8. Recent Researches on the Formation of Snow Crystals
- Appendix. Classification of Snow Crystals for Practical Purposes

Bibliography and References

Plates

Index

In addition to the 197 pages of plates at the end of the book showing photomicrographs of snow crystals, each chapter is most generously illustrated with additional photomicrographs and sketches of snow crystals.

The photomicrographs in general are very clear. The book is printed on good paper and is well bound in a hard black cover, and measures 10 inches by 7 inches.

There is a wealth of written information on the formation of snow crystals, but its great value to the average mineralogist, geologist, student and to the layman lies in the illustrations. This book is a must for every school and departmental library and would enrich the library of anyone interested in mineralogy.

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