

## BOOK REVIEWS

MINERALS FOR ATOMIC ENERGY, by ROBERT D. NININGER. xii+367 pages, black and white and color plates; charts. D. Van Nostrand Company, New York, 1954. Price, \$7.50.

The scope of this book is much broader than is indicated by its title, or even the subtitle, "A Guide to Exploration for Uranium, Thorium, and Beryllium." Nininger is currently Acting Assistant Director, Division of Raw Materials, United States Atomic Energy Commission. He has been associated with the Division of Raw Materials for years and can write with authority on the subjects treated.

Part I (110 pages) is a description of the important minerals and significant deposits of uranium, thorium, and beryllium. Part II (50 pages) is a world-wide geologic and geographic evaluation of potential areas of production of "atomic minerals." Part III (63 pages) tells one how to prepare for prospecting, describes equipment and its use, calls attention to certain regulations, and tells how to evaluate a claim in terms of current prices and market conditions.

Much additional information is given in 16 well chosen appendices (126 pages). The first five give more data on minerals and ore deposits, including tables for identification of the former and a classification of the latter. Instructions for obtaining analyses or assays are also included. The other appendices provide information about manufacturers of equipment, mining laws and prospecting conditions in the United States, Canada, Australia, and the United Kingdom and British Colonial Territories. Sources where additional information can be obtained are also listed.

The author makes no claim of originality for any of the subjects treated. He has drawn information from a wide variety of sources including text-books of mineralogy, circulars and other publications of the U. S. Geological Survey, the U. S. Bureau of Mines, and the Atomic Energy Commission, mining laws of nine western states and various federal agencies, and publications of the Canadian, British, and Australian Governments. Where these sources are not quoted directly the information is summarized succinctly, so the volume is about as authoritative and up-to-date as such a work can be made.

It is inevitable in a compilation from so many sources that some usages and interpretations should creep in that are out-of-date, in error, or at least open to serious question. For example, the definition of an element in footnote 1 on page 11 no longer holds; elements with more than one isotope may be composed of atoms with quite different physical properties.

Throughout the book *niobium* is referred to as *columbium*. The American Chemical Society has adopted *niobium* and the usage should be made uniform.

On page 40 it is stated that, "The uranium (in the Chattanooga shale) is believed to be associated with the clay minerals." Breger, Bates, and others have shown recently that there is a positive correlation between uranium and organic material, but a *negative* correlation with clay minerals.

Uranium minerals formed at the same time as the enclosing sedimentary rocks are referred to as *secondary* (pages 42 and 59). This is not in accord with accepted usage; secondary minerals are formed *in situ* by alteration or replacement of pre-existing ones.

On page 73 the Wind River Basin is said to be "bounded by (the towns of) Lander, Thermopolis, and Casper." This is an unusual method of giving the boundaries of a basin; moreover, Casper is some 40 miles east of the limits of the basin; Thermopolis, more than 10 miles north.

If uranium has a "steady rate of precipitation from sea water" (p. 75) then the red muds of the deep ocean basins should be the most highly radioactive marine sediments. Such is not the case.

The maps on pages 78-79 give an exaggerated idea of the uranium deposits in the United States; many occurrences of uranium minerals are shown in the U. S. that are not workable deposits. The locality shown in North Dakota as *Slim Baites* should be *Slim Buttes*.

The deposits of the Colorado Plateau are said to be of Mesozoic age (p. 114). They are in Mesozoic sedimentary rocks, but the best radioactive age determinations indicate that the uranium deposits were formed during the Tertiary. A notable exception to the statement that nearly all uranium deposits are Precambrian, Mesozoic, or Tertiary in age is the classic occurrence at Joachimsthal, Czechoslovakia, which is late Paleozoic.

On page 145 the impression is created that nitrate and borate deposits occur together on the west flank of the Andes in northern Chile. Actually, the nitrate deposits occur on the east flank of the coast range and the borates extend through to the east flank of the Andes in southern Bolivia and northwestern Argentina.

Gummitz is said (p. 223) to be composed of uranium, lead, barium, calcium, etc.; the oxides of these metals are its components, of course.

Typographical errors are fairly abundant throughout the book but for the most part they are quite evident and not important enough to require mention in a review.

The five colored pictures of uranium minerals are fairly true and representative, but the one of bead tests (opposite p. 236) has such poor registry, at least in the copy sent to the reviewer, and most of the colors are so far from the real ones that it would have been better to omit the plate and rely on the descriptions of the colors in the tables that precede the plate.

There are books that give much more detailed information on uranium minerals, others on counting methods, still others on mining laws, but Nininger's *Minerals for Atomic Energy* gives better coverage of more different kinds of information on searching for these minerals than any other single volume. For this reason it is useful for reference to the professional geologist as well as to the prospector or interested layman.

EARL INGERSON,

*U. S. Geological Survey, Washington 25, D. C.*

#### THE USE OF STEREOGRAPHIC PROJECTION IN STRUCTURAL GEOLOGY,

By F. C. PHILLIPS. Edward Arnold, Ltd., London, 1954, vii+86 pages. Price, \$3.00.

In the last two decades structural geologists have turned more and more to stereographic projection for the solution of problems involving directions of intersecting lines and planes. Although this method cannot determine distances, such as the throw of a fault or the magnitude of a stratigraphic interval, it solves in a matter of minutes problems involving only angles and directions that would take hours by the classical approach of descriptive geometry.

There are many examples in earth science journals of the solution of individual problems by stereographic projection, but most textbooks of structural geology mention it only casually, if at all. Bucher (*Jour. Geol.*, 52, pp. 191-212, 1944) in a "study for students" outlined the methods of stereographic projection and the solution of 13 typical problems. Phillips discusses more than twice as many problems and several kinds not mentioned by Bucher.

Phillips' book is thus the most complete and detailed account yet written of the application of stereographic projection to structural and tectonic solutions and interpretations. There is an introductory chapter on the principle of stereographic projection, one each on true and apparent dip and intersecting oblique planes, two on rotation, one on stereographic projection as an auxiliary and one on tectonic syntheses. In this final chapter the elements of preparation and use of statistical (petrofabric) diagrams are treated very briefly. There is

a 10 page appendix on calculations by spherical trigonometry, followed by a list of suggested exercises and answers.

The style is clear and straightforward and it is easy for one who is experienced in these techniques to follow the constructions and solutions. Not all of the steps (positions of the projection with respect to the net) are shown, however, so a beginner is likely to experience some difficulty in following parts of the discussion. It would have been well to have included all of the steps, at least through Chapter III, or to have admonished the novice to use a piece of tracing paper to follow the steps omitted.

There are other evidences of saving space at the expense of clarity. For example, Figures 17 and 42 are geometrical constructions to illustrate the complexity of the classical solution for two of the problems. There are no letters or figures to indicate what the lines mean and no hint of the method used or steps required. The figures might as well have been omitted with the statement "a minimum of  $x$  lines would be required to solve the same problem geometrically."

The book is remarkably free of typographical and other errors. Only one requiring mention was noticed: on pp. 15 and 16 the dips of the planes plotted in Fig. 24 are given in the text as  $64^\circ$  to the east and  $58^\circ$  to the south, but on the projection these values are reversed. If the values given in the text are used then the values at the top of p. 16 are "trending E  $52^\circ$  S and plunging  $52^\circ$  southeasterly."—While perhaps not actually an error it seems peculiar to speak of projecting the *poles* of lineations (pp. 61–62), meaning the directions of the lineations themselves.

This book will be very useful for practicing structural geologists as well as to students, although nowhere in the book is the use of small "notebook" nets for solutions of problems in the field mentioned. It is unfortunate that so important a subject had to be so compressed; at least twice as many pages could have been used to advantage in expanding the scope of the treatment and in giving more detailed discussions of some of the material included.

EARL INGERSON,

*U. S. Geological Survey, Washington 25, D. C.*

EINFÜHRUNG IN DIE UNTERSUCHUNG DER KRISTALLGITTER MIT RÖNTGENSTRAHLEN, by FRIEDRICH TREY AND WILHELM LEGAT. Vienna, Springer-Verlag, 1954, ii+112 pp., 56 figs. and 1 nomogram, 14×21 cm. Paper-bound. Price \$3.00.

In writing this short text the authors have set themselves the task of presenting, in an elementary way, the geometrical theory of the diffraction of  $x$ -rays by a "lattice." Thus, they intend the book to serve as an introduction to the more advanced treatments on the theory of the diffraction of  $x$ -rays by crystals.

The one-dimensional, two-dimensional, and three-dimensional cases are treated in that order. First, the interaction of  $x$ -rays with a row ("eindimensionale Punktgitter" or "Liniengitter") is considered; this is followed by a discussion of the diffraction by a net ("zweidimensionale Punktgitter" or "Kreuzgitter"); finally, the case of the lattice ("dreidimensionale Punktgitter" or "Raumgitter") is treated. Laudably, the concept of the Ewald reciprocal lattice (in appropriate dimensions) is introduced early in the text and is used extensively in developing the theory. This reviewer has never been able to understand why the very powerful reciprocal lattice concept is usually so studiously avoided in elementary texts of the present kind.

Following the general development of the geometrical theory of diffraction, several specific techniques for studying crystals are described. These are the Laue, powder, and rotating crystal methods. No moving-film methods are considered. As part of the discussion of the powder method various techniques (all photographic) are described, including the Straumanis asymmetric film technique, and various back-reflection methods.

One of the interesting and useful features of the book is the use throughout of problems and their solutions. These problems vary from the most elementary and self-evident types to those of greater complexity and should be of immense help to anyone attempting to use the book for self-study. The general format of the book is excellent: the type is pleasing to the eye, and the line-drawings and photographs are numerous and of very high quality.

On the other hand this book has its faults. A very serious one is the fallacy of identifying lattice points with atoms, apparently in an attempt to achieve simplicity of development of the diffraction theory. To coin a phrase "a lattice is a lattice is a lattice" (and not a structure). In a similar manner the unit cell is defined in a completely misleading way. The authors also run into rough going when they discuss centered lattices, falling back on the obscure device of defining these in terms of interpenetrating primitive lattices. Again, KCl is used as an example of a substance having a primitive cell. It is mostly in the superposition of the necessary physical concepts on the purely geometrical ones that the book is deficient.

Aside from the language barrier this book would be useful to the student providing that supplemental help is available in the form of personal guidance or some text which presents the necessary physical concepts more adequately.

C. L. CHRIST,

*U. S. Geological Survey, Washington 25, D. C.*

CRYSTAL DATA. CLASSIFICATION OF SUBSTANCES BY SPACE GROUPS AND THEIR IDENTIFICATION FROM CELL DIMENSIONS. By J. D. H. DONNAY AND WERNER NOWACKI with the collaboration of Gabrielle Donnay and many assistants. Pp. ix+719. Memoir 64 of The Geological Society of America, 419 West 117th St., New York 27, N. Y. (1954), Price \$5.00.

This important book is divided into two parts which were prepared independently of each other. Part I, by Professor Nowacki of Berne, is an expansion and revision of earlier publications. It consists mainly of a table of 76 pages in which 3,800 substances, grouped in 6 inorganic and 6 organic chemical categories, are listed by space groups. This is based on the literature to 1948 and references are given. A ten page statistical table records the number of substances in each of the chemical categories in every space group. The distribution is most uneven. For 41 space groups there are no representatives.  $C_{2h}^5$  is the most favored space group for organic compounds (265) but also harbors 90 inorganic substances.  $O_h^5$  is the most favored space group of inorganic materials (289) but also includes 24 "organic compounds" all but one of which are "inorganic compounds with organic radicals." Shorter tables summarize the distribution of crystalline substances among the systems, classes and translation groups and the percentage distribution among the "most frequent" space groups.

Part II, Determinative Tables for Identification of Crystalline Substances from Cell Dimensions, by the Donnays, fills four-fifths of the volume. Any scheme for the systematic identification of crystalline materials depends upon the compilation of data in suitable form. The data in Groth's 5 volume *Chemische Kristallographie* were in a form not convenient for the identification of crystals from morphology. *The Barker Index of Crystals*, when completed, will give these data for non-cubic crystals in suitable form. Mineralogists have long enjoyed the advantages of the Larsen and Larsen-Berman tables for identification of "non-opaque" minerals by means of their optical properties. In recent years the identification of crystalline materials by means of x-ray powder diffraction patterns has been much in vogue. It is full of pitfalls for the unwary. In the introduction to Part II Donnay says "Since identification by powder diffraction data cannot, in all rigor, be considered reliable until all the lines have been indexed, or matched with those of a previously

indexed standard, the knowledge of the cell dimensions and diffraction aspect actually is a prerequisite to a safe application of the powder method. Although single-crystal data obtained by  $x$ -rays are given in several compendia, they are not listed in such a manner as to be useful for determinative purposes."

Part II contains A. Introduction, B. Determinative Tables, C. Appendix—Tables of Space Group Criteria, followed by name and formula indexes that serve both parts. The introduction is devoted largely to "choice and orientation of the cell." This must be carried out according to conventions which have been followed in preparing data for the tables. Six general rules are followed by an explanation of their application in each of the systems. Following a brief statement of the use of the Delaunay reduction, monoclinic reorientations, orthorhombic transformation and the rhombohedral to hexagonal transformation are explained, each with the aid of a numerical example worked out in detail. The tables give data on about 6000 substances, covering the literature through 1951. Cubic materials are listed in order of increasing  $a$ , others in order of increasing axial ratios within each system. The data in the tables are partly arranged in columns. For monoclinic crystals these have the headings  $a/b$ ,  $c/b$ ,  $\beta$ ,  $a$ ,  $b$ ,  $c$ , *Space group*, *Z*, *Struct. type*, *Spec. grav. meas.*, *Spec. grav. calc.* Other information given includes name and synonyms, chemical formula, literature references, notes on pseudosymmetry and pseudocells, on original cell constants where these had to be transformed to obtain the conventional setting, on cleavage, color, crystal habit, polymorphs, errors in the literature, cross references, and much other useful material. The data on minerals have been recorded with understanding as shown by the mention of localities and the treatment of members of mix-crystal series.

A puzzling point is the listing of several space-group possibilities for substances with well-established structure. For cubic sodium perchlorate, for instance, the space group is given on page 523 as " $F\bar{4}3m$  or  $F23$ " with reference to "SB II, 411." The space group is, to be sure, given in this fashion in *Strukturberichte II*, page 411, but two pages farther on in the same work, based on another source, it is given as  $F\bar{4}3m$  and this is recorded on page 522 in Part II. The description of the structure as type  $HO_8$  (SB II, 84) leaves no doubt that it has this symmetry. Cubic sodium perchlorate and the many other perchlorates of like structure are not listed in Part I. Though the citation of multiple choices for space groups in such cases may be evidence of commendable caution it seems to this reviewer that it can be misleading. It gives the impression that doubt remains concerning the symmetry of a structure even though it is fully established.

The tables in the appendix are a revision of similar tables published by Donnay and Harker under the title *Nouvelles Tables d'Extinctions pour les 230 Groupes de Recouvrements Cristallographiques*, *Naturaliste Canadien*, 67: 33–69, 1940. They have been brought into conformity with usage in the *International Tables for X-ray Crystallography*, 1951. This results in differences in space group designations between the appendix and other parts of the work. For instance, the Schoenflies group  $D_{6h}^1$  is designated  $P6/mmm$  in the appendix and the table of Part II, but  $C6/mmm$  on page 584 in the "Concordance of Space Group Notations" and in Part I. The treatment of the monoclinic space groups in the appendix (table 15, page 587) provides for three (or four) orientations but leaves out the orientations which would involve  $n$  glides. Thus the space group symbol  $P2_1/n$ , which is appropriate for monazite and scores of other substances in  $C_{2h}^5$ , is not found in table 15. Since these orientations would involve "criteria" and "aspects" different from those given for the orientations included in the table, the basis for the exclusion is not apparent to this reviewer.

The technical points just raised are mentioned only because it seems that they are connected with fundamentals. Not even a slight derogation of the work under review is intended. The volume has been put together almost faultlessly. Misprints are few when one considers the magnitude of the task that has been performed. All crystallographers

should be grateful to the authors and to the Geological Society of America for making so much valuable information available in such attractive, convenient and inexpensive form. This reviewer has spent pleasant hours just browsing through the tables enjoying the bits of intriguing information. But the volume can be put to much more solid uses and not only in the identification of crystalline substances. In its pages can be found suggestions for many problems in crystal chemistry and the solutions of others. This book is highly recommended to all mineralogists and crystallographers and it is hoped that it may lead some to realize the advantages of single crystal *x*-ray examination for purposes of identification.

A. PABST,

*University of California, Berkeley 4, Calif.*

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#### FOURTH NATIONAL CLAY MINERALS CONFERENCE

The Conference will be held at The Pennsylvania State University Monday through Thursday, October 10-13, 1955. Field trips and laboratory visits will take place Monday, and papers will be presented Tuesday, Wednesday, and Thursday. The program will include a number of special sessions in addition to those of general interest. The following topics will be given particular emphasis: mixed-layer clays; thermal transformations; and clay water systems. A number of prominent scientists from abroad have been invited to attend and will present reports on the status of clay mineral investigation in their respective countries.

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