BOOK REVIEWS

GEOLOGY OF THE INDUSTRIAL ROCKS AND MINERALS, by ROBERT L. BATES, 424 pages, Harper and Brothers, 1960, $10.00.

The author is professor of geology at Ohio State University and a columnist ("Geology in the Public Eye") for *GeoTimes*. This book is a Lindgren-type approach to rocks and minerals of industrial value; in other words, its motivation is geologic rather than economic. It is, therefore, an innovation among books concerned with the non-metallics.

After a brief introduction the author devotes four chapters to the industrial rocks and five to the industrial minerals. The industrial rocks are igneous (granite, basalt, pumice, *et al.*), metamorphic (slate and marble), and sedimentary (two chapters, one covering sand and gravel, sandstone and clay, and the other the carbonate rocks, phosphate, rock gypsum, and salt). The industrial minerals are divided into the igneous, vein and replacement, metamorphic, sedimentary and sulfur, and minor industrial. This reviewer believes that the "minor industrial minerals," of which there are eight, covering nine pages, should either be distributed back through the preceding chapters where they belong or omitted entirely. In all, thirteen rocks and twenty minerals are described.

Within the discussion of a particular rock or mineral the general uses, properties, and origin are covered first, and then the principal occurrences (mostly in the United States) are described, some in considerable detail and with extensive bibliographies. This is the author's main contribution, in my opinion. I know of nowhere else where one can get, in one volume, an adequate modern review of the *geological occurrence* of the principal domestic deposits of these industrial rocks and minerals.

An entirely satisfactory classification of the non-metallics is impossible, as the author implies in his introduction. He has attempted to put together the best possible classification for a strictly geological approach. The teacher, if using this book for a text, will either have to accept this classification or jump around like a flea on a hot skillet if he follows the traditional approach. For example, if the subject under consideration is dimension stone, the particular rocks involved will be found in all four chapters on industrial rocks. The same chapters would be involved in a study of raw materials for concrete aggregate, or roadstone. If refractories are taken up as a unit, parts of two rock and three mineral chapters would have to be covered. But other classifications present other problems, so one has to adapt in any case.

The book is both readable and authoritative. It, no doubt, will have wide use as a text, and in addition should be in the personal library of everyone interested in industrial geology.

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TECHNICAL PETROGRAPHY OF PRODUCTS OF REFRACTORIES, WHITEWARE-CERAMICS AND HYDRAULIC BINDERS (Technische Petrographie von Erzeugnissen der Feuerfest-, Feinkeramik- und Bindemittelindustrie), by D. S. BELJANKIN, B. W. IWANOW, AND W. W. LAPIN; German Edition by JOHANNES WINKLER (Institute of Glass Technology, Coswig).—Bauverlag G.m.b.H., and VEB Verlag Technik, Berlin, xvi+455 pp., 216 text figures.

It is with a feeling of deep respect that the reviewer wants to give his impression of the present book in the memory of his late friend, with whom the best tradition of Russian petrography of the great school of Loewinson-Lessing and E. Fedorow has ended. The book is by no means a common text book; it does not give any instructions for the use

of the petrographic microscope or of the techniques of the examination of minerals in polished sections. It is, however, the summary of a rich life of research and experience, a mine of wealth for all investigators who wish to compare their observations in applied mineral microscopy with the data collected by a master in this art. Beyond that, the book is an indispensable source of information on the not always easily available Russian literature of the last four decades in the fields of microscopic investigation of the constitution of ceramic products. The bibliographic collection of this literature extending over the last 40 pages of the book is practically unique, and therefore most important for more detailed studies. The book is a first-class reference collection supplementing similar works in English and German languages, chiefly the books of F. H. Norton and K. Konopocky on Refractories or that of H. Salmang on Ceramics in General, but also comparable to the well-known work of H. Insley and V. D. Frechette on the microscopy of ceramics, cements, slags, and glasses. It is a truly Russian book, entirely based on experience with Russian raw materials and Russian industrial products, but for just this reason of utmost interest. The reviewer is of the opinion that it is indispensable for the American investigator to learn from the rich data offered; it manifests in a particular degree the tremendous advance which industry (not only in the countries of the U.S.S.R.!) owes to the microscopist by the careful study of their materials. On the other hand, it is much to regretted that the book does not contain much information beyond the year 1950 (the book appeared first in Moscow, 1952).

The first Section of the book treats the Refractories, classified as silica: alumina-silica; highly aluminous and corundum products; magnesia refractories, chrome magnesia refractories; magnesium silicate materials; dolomite products; spinels. A very interesting supplementary chapter is concerned with the reaction products between silica and fireclay, or magnesia brick. The second large Section concerns the porcelains of the classical type, and the modified steatite porcelains, cordierite materials, etc. A special chapter is dedicated to the sintered alumina products and to special porcelains on the basis of zirconia, alkaline earth titanates, and of beryllia. The third large Section is that on hydraulic Binders, Portland cement, alumina cement, and their hydration products. A supplement considers gypsum plasters.

Especially in the first two sections the full mastership of Beljankin and his school is evident. With a nearly infinite carefulness the microscopic constitution of ceramic products of all kinds are described, analyzed in their mineral ingredients, and their chemical-petrographic reactions discussed with the surroundings. The practitioner will learn many details from this rich experience even if he never comes in contact with the Russian raw materials from which the products described by Beljankin have derived. These chapters have many parallelisms with what we observe in American raw materials and industrial products. There is a wealth of mostly excellent micrographs, valuable tabulations of chemical bulk analyses and graphs. In everything, the exact petrographic identification of the mineral constituents is in the foreground of discussion and the final conclusions are based on the accurate determination of the optical constants. Over 90 per cent of the methods used are of the classical ones with the polarization microscope; only occasionally is reflected light examination added if opaque minerals participate in the constitution of a given sample. In this point the American reader will be perhaps somewhat disappointed. Especially in the third Section on hydraulic binders the microscopy of Portland cement clinkers and the special methods in use of production control are still somewhat "underdeveloped." The nature of the hydration products of Portland cement was not yet a well known field when Beljankin finished his book, and even the excellent methods of B. Tavasci on the differentiation of the constituents of the Portland cement clinkers by etching methods are not sufficiently appreciated in their importance for modern clinker microscopy. Never-

theless, Beljankin spent much work on studies of the constitution of aluminate cements, and in his book tabulations of the powder diagram data of x-ray diffraction are found side-by-side with the fundamental optical data for all the important minerals of hydraulic binders. Beljankin was a sincere investigator zealous in having all his data accurate and reliable. He defended also with fervor clear definitions and precise wording, and he is a sharp critic of "liberties" which occurred in the International literature by arbitrary definitions. He really hated confusion arising if authors abused mineral names for industrial products or in physical-chemical conditions inadequate to the petrographic units in which they are found in nature. Equally sharply he criticizes the tremendous confusion which unfortunately exists in the literature of the Western hemisphere in the definition of polymorphous modifications. The uniformity of definitions of modifications as it is evident not only in Beljankin's book but all over the Russian literature, contrasts impressively with the confusion in our common textbooks and reference books. Beljankin is right when he assures that it is most unfortunate when authors forget every rule established on thermodynamic principles and define modifications they discovered rather à son gré. The reviewer must sympathize with Beljankin, because it is alarming how the confusion in this important field has grown in the last decade; and there is in our Western literature no sign of any improvement. Videant Consules! It is of minor importance that even such an accurate mineralogist as Beljankin occasionally slipped into errors of phase identification, *e.g.* he defined a typical iron-alumina spinel as gahnite (in the place of hercynite), or that he does not believe in the reality of protoenstatite, and some other slight misconceptions which are easily forgivable. The general tenor of the present book is so excellent that one also cannot object too much against some broadness in the text. One must regret to a higher degree that the sections on metallurgical slags, inclusions in steel, or of stones in glass have been omitted in the German translation which are an important part in the Russian original.

The printing of the book was done with great care, especially in the beautiful micrographs and well-readable graphs; the publishers may be congratulated for the very good make-up of the book and the valuable indexes added to the text. A particular appreciation must be given to the translator who mastered the difficult original text and has given in the German-written edition a most helpful tool to Western investigators to get fully acquainted with the rich results of Beljankin and his school.

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OPTISCHE DATEN ZUR BESTIMMUNG ANORGANISCHER SUBSTANZEN MIT DEN POLARISATIONS-MIKROSKOP, by Ernst Kordes. 192 pp., 8 charts (in rear pocket), 8 figures, 2 color plates. Verlag Chemie, G.M.B.H., Bergstrasse, Weinheim, Germany. 1960. DM 43.00 ($10.75).

Professor Kordes, who is Professor of Crystal Chemistry at the University of Bonn, has performed an outstanding service to chemists, crystallographers and mineralogists in compiling data for the optical identification of 1771 inorganic compounds. The introduction and a list of the abbreviations and symbols used are followed by the general section of the book, divided into chapters dealing successively with (1) Determinative methods for inorganic substances by means of the polarizing microscope in transmitted light. (This includes the two color plates depicting chiefly interference figures.) (2) A one-page diagram indicating the sequence of determining the optical characteristics with the polarizing microscope in transmitted light, (3) A list of liquids for the immersion method. (This is completely out of date and should be disregarded.) (4) A brief list of heavy liquids for

mineral separation. (This also requires modernization and expansion.) (5) A one-page list of major references. The only work cited from the relatively extensive modern literature on ceramic compounds is the Glastechnische Tabellen of Eitel *et al.* which was published in 1932.

The second part of the work begins with a description of the tables and charts. The main section which follows, consists of two sets of tables: (1) a descriptive set Table 0 (isotropic substances), Tables 1+, 1− (uniaxial positive and negative), Tables 2+, 2− (biaxial positive and negative), and Table 2± (biaxial with unknown sign); and (2) a determinative set. In the latter the arrangements are by increasing indices with separate tables for both ϵ and ω for (+) and (−) uniaxial crystals and for both γ and α for (+) and (−) biaxial crystals. Each substance in the descriptive tables receives a number (Table number plus a decimal species designation) to which reference is made in the determinative tables and in the following table which lists the mineral name equivalents of those substances that occur naturally. An alphabetical list (alphabetically by chemical symbol) closes the book. Charts 1–3 plot index versus birefringence, charts 4–8 plot specific gravity versus indices.

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ULTRAVIOLET GUIDE TO MINERALS, by Charles M. Riley, Van Nostrand Co., Inc., Princeton, New Jersey, x plus 244 pages, 16 color and 8 black-and-white photos, price $6.95.

This is a welcome, practical handbook on fluorescent minerals. It is written clearly and is well illustrated. The text serves the needs of both the technical and popular reader. The author's treatment of the subject matter is more applied than theoretical; however, many modern and new applied techniques are discussed or suggested.

In addition to the applied concepts, Mr. Riley amiably contributes a long-needed collection of knowledge pertaining to fluorescent minerals in the form of seven tables, one for each color. The tables enable the investigator to compare the fluorescent color of his specimen with the chart for that color, thus narrowing down his search to a few possibilities. Then, with the aid of the accompanying data the searcher can readily determine the mineral species.

This handbook is recommended for collectors, lapidaries, prospectors, and technical investigators.

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SYSTEMATIC MINERALOGY OF URANIUM AND THORIUM, by Clifford Frondel. U. S. Geological Survey, Bulletin 1064. 400 pp., 1 plate, 24 figures, 8 tables, 1958. Supt. of Documents, Gov't Printing Office, Washington 25, D. C. $1.50.

Unfortunately not reviewed in *The American Mineralogist* at the time of its publication two years ago, this monograph deserves widespread recognition as an authoritative reference on the properties and characteristics of many uranium and thorium minerals. It includes not only a critical selection of data from the older descriptions, but also represents the summation of much original research by Frondel, his associates and his students, the results of many of which have previously appeared in the last several years in *The American Mineralogist* as contributions from the Department of Mineralogy and Petrography of Harvard University.

Already, of course, a large number of new uranium and thorium minerals have been described since the manuscript went to press and a supplement is clearly in order.

The general section of the bulletin presents a brief review of the history of the study of radioactive species followed by statements on radioactivity, on its use in age determination, on autoradiography and on radiation damage in crystals. These short sections, in their present form, are actually of but minor service to the main purpose of the work and should either be expanded or omitted.

Nearly 90 species are described according to synonymy, composition, crystallography, habit, physical and optical properties, synthesis, identification and formation and occurrence in nature. One of the most valuable features is the incorporation of *x*-ray powder spacing data obtained on authenticated material. The descriptive section is followed by identification tables in which the species are arranged to their d-spacings, composition, optical properties, color, specific gravity and fluorescence. More than 800 references document the monograph.

Only two regrets trouble this reviewer: one, that the work was so long delayed in press (no fault of the authors), and two, that Professor Frondel failed to include descriptions of many other species that contain significant amounts of uranium, thorium or both. The choice under the multiple oxides seems particularly arbitrary, and this section surely remains incomplete without the inclusion of such species as euxenite, fergusonite, samarskite, etc., as well as a discussion of the identification problems of the various phases that appear, attendant upon recrystallization in air and neutral atmospheres. Likewise should such silicates as gadolinite, chevkinite and allanite be overlooked? The last is a particularly widespread radioactive mineral, and its content of radioactive elements varies much as does that of monazite in which Th is also essentially a "vicarious element," but which is described. These are but minor disappointments in an otherwise outstanding and extraordinarily useful piece of work which can only be improved in any major manner by a much-to-be-hoped-for supplement.

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SEAMAN'S MINERAL TABLES, by Kiril Spiroff. The Michigan College of Mining and Technology Press, Houghton, Michigan, 1959. 82 pages (ring binder 11×8½). $2.50.

This book is essentially a revision of *Mineral Classification According to Cleavage and Crystal Habit,* fourth edition, by W. A. Seaman. The latter, which has been out of print for a number of years, found long usage in courses in mineralogy at the Michigan College of Mining and Technology.

The present tables are arranged essentially as in the previous work. The major portion of the tables is based upon cleavage, desirable from the point of view of constancy among individual specimens of minerals. The first minerals listed are those with one cleavage (pinacoidal) or one cleavage much better than the others, followed by minerals with two cleavage directions, alike (prismatic) or different (two pinacoidal directions) and with specified angular relations. The complexity of the cleavage increases progressively and systematically through the tabulation. The last section of the cleavage tables is six directions, all alike, with angles of 60° and 90° (dodecahedral). Cleavage perfection is divided into seven categories. Within the basic framework of cleavage geometry, the minerals are listed according to luster, cleavage perfection, and angular values.

In addition to the tables based upon cleavage, other tables based upon crystal morphology, luster (arranged by color), streak (if diagnostic), and taste, are included. Also given are tables of fibrous minerals with no streak and nodular or earthy minerals. A chart of

the classification of the igneous rocks is particularly noteworthy. Also a chart of sedimentary rocks and their metamorphic equivalents is given.

Drawings of several crystals are shown. An error of projection appears in the clinographic projection of the orthorhombic crystal.

The introductory remarks are rather chatty and seem to be directed to the amateur mineralogist. For example, "Someone once said, 'To be a mineralogist you have to be a queer duck with pockets and car full of odd trash called "minerals." ' But we know there is more to it than that." A sort of history of mineralogy is included in the introduction. Various physical properties of minerals are discussed. Within the text, several pages are devoted to the calculation of the empirical chemical formulas of minerals, with worked-out examples. The tables are intended to be used in conjunction with *Dana's Textbook of Mineralogy*, 4th edition, Wiley, 1932. Page references are given and the letters referring to crystal forms follow the Dana usage.

The book is a valuable compilation, in that it includes a rather large tabulation of the macroscopically observable cleavage of minerals, appropriate to the long tradition at the Michigan College of Mining and Technology of the use of cleavage as a major determinative property of minerals. The reviewer detected no errors in the tabulation, although he does not pretend to be familiar with all of the minerals listed. The large number of rare minerals may tend to confuse the beginning student, unless the primary object of his course of study is a systematic approach to the methodology of mineral identification by cleavage and crystal form. It is hoped that a future edition will employ various sizes of type and style of listing to indicate the approximate relative importance of the minerals tabulated. The chemical compositions of the minerals would add to the usefulness of the book, as would an index of species.

While *Seaman's Mineral Tables* is not in itself suitable for most elementary or intermediate courses in mineralogy as generally taught today, the reviewer considers it a very useful reference.

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OPTICAL CRYSTALLOGRAPHY, by Ernest E. Wahlstrom. 3rd Edition (1960), John Wiley and Sons, Inc., vii+356 pp.

The first and second editions of Optical Crystallography (2nd Edition reviewed, *Am. Mineralogist*, **36,** p. 924) have enjoyed wide acceptance for use as standard textbooks in beginning crystal optics courses. The third edition, which has been expanded and revised, should continue to be of value, not only to the mineralogist and geologist, but to workers in other fields as well.

The general format of the textbook remains essentially unchanged from that of the previous editions. As in the previous editions, the author has avoided a purely mathematical approach to the subject in favor of a practical, graphical presentation suitable for the beginning student's use with the polarizing microscope. The many new figures added to the third edition continue to maintain the high quality of illustration exemplified by its predecessors. Several sections have been rewritten and reorganized, and the expanded chapter dealing with crystal rotation methods, especially the detailed instructions on the use of the universal stage, will be of special value to the student.

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