

BOOK REVIEWS

MATHEMATICAL CRYSTALLOGRAPHY AND THE THEORY OF GROUPS OF MOVEMENTS, by HAROLD HILTON. Dover Publications, Inc., New York, 1963, 262+xii pp., \$2.00.

This work was originally published by Clarendon Press, Oxford, in 1903. It is essentially a compilation and reorganization of the theory of crystallography which had been developed to that date and is based principally on the work of Schoenflies. Thus, starting from first principles, the point groups, translation groups and space groups are derived, as are the theorems necessary for this process. The value of the exposition, as opposed to that of most other texts on elementary crystallography, lies in the basis of the analyses on elementary group theory and in the fact that it is a derivation, rather than a presentation, of results.

This book should be of interest only to specialists in crystallography. In addition, its principle value lies in large part in its historical merits—that is, in presenting the state of the art, at the time of first publication, when only indirect evidence of its application to crystal structure was available.

The presentation is too detailed in large part for classroom application, particularly since at least one textbook exists which is much more practical in this respect, as do other expositions of group theory, including crystallographic applications.

The price is only \$2.00, however, and although a paperback, this is one of the Dover series and therefore of very high quality. It should prove of interest to crystallographers, if only for its historical value.

DONALD R. PEACOR  
*The University of Michigan*

CRYSTALLOGRAPHIC DATA ON METAL AND ALLOY STRUCTURES, compiled by A. TAYLOR AND BRENDA J. KAGLE. Dover Publications, Inc., New York, 1963, 263 pp., \$2.25.

This is a compilation of crystallographic data as obtained from the ASTM Powder Data File, Pearson's "Handbook of Lattice Spacings and Structures of Metals and Alloys," Structure Reports, Strukturberichte, and the Landolt Bornstein Tables. For each of the approximately 3000 materials covered, data presented include, when available, the formula (alphabetic listing), crystal system, structure type, ASTM data for the three most intense powder lines, space group, lattice parameters and the number of formula weights per cell. The compounds are divided into three sections entitled: 1. Alloys and Intermetallic Compounds; 2. Borides, Carbides, Hydrides, Oxides and Nitrides; 3. Elements.

Space limitations necessarily require that data be given for only single members of solid solution series. This, and other shortcomings common to such compilations, require that the data be used with care. Only a very few of the compounds presented are minerals, but this certainly does not significantly detract from its usefulness to mineralogists. Other compilations exist, some more comprehensive, for which this volume should be a valuable supplement, and the price for this paperback (\$2.25) makes it a bargain relative to the data it contains.

DONALD R. PEACOR  
*The University of Michigan*

THE PRECESSION METHOD, by M. J. BUERGER. John Wiley and Sons, Inc., 1964, 276 pages, \$13.50.

This book is written in the same elegant language and received the same systematic treatment readers have been accustomed to in the previous five books of Professor Buerger. "The Precession Method" is a comprehensive book on both the theoretical and practical aspects of the method identified in the title. It is a book which can serve equally well as a text in the class and as an extensive manual in the laboratory.

The author begins with a review of the historical background and the development of the precession method and describes the principles and the geometry of the precession camera through a discussion of the Laue cones. In the following chapters he presents detailed information on the practice of the precession photography, including the interpretation of the reciprocal-lattice photographs, the analysis and correction of common errors, and the treatment of intensities for their use in crystal-structure determination. These chapters, even more clearly than other portions of the book, are saturated by the reflection of the author's experience.

The book offers comments and references on recent developments of the method and gives the model of a future, equi-inclination precession camera. The reproduction of various tables and charts augment the practical usefulness of the book, and the extensive bibliography provides sufficient references for additional but not frequently required details on special applications of the method.

The general appearance of the book is very pleasant, undoubtedly due to the simple but efficient style of illustrations and the neat work of the publisher. Unfortunately, the price of the book is relatively high.

Success for "The Precession Method" can be safely predicted. The reviewer feels that no active crystallographer can afford not to have a copy on his bookshelves, in the section of the most frequently used volumes.

TIBOR ZOLTAI  
University of Minnesota

KRISTALLY MINERALOV, CHAST' I: PLOSKOGRANNYE FORMY, by I. I. SHAFRANOVSKIĬ. Izdatel'stvo Leningradskogo Universiteta, Leningrad. 1957, 222 pp., 11r.25k. (about \$1.25).

If I had not had so much trouble with the language, this remarkable book would have been reviewed long ago! The author occupies the chair once filled by Fedorov at the Mining Institute in Leningrad. Under the title "Crystals of Minerals", he proposes to publish several volumes. The first one is devoted to "Forms with plane faces". It comprises four chapters.

After some introductory material, the crystal forms are derived and named according to the Boldyrev terminology (which is on its way to becoming international).<sup>1</sup> Two intersecting physically similar faces constitute a *dihedron*,<sup>2</sup> whether with symmetry 2 (formerly "sphenoid"), or *m* (formerly "dome"), or *mm2* (which should have been called "dome-sphenoid"). The 230 space groups are tabulated, with lists of minerals known to crystallize in each one of them (601 minerals are mentioned). Although there exist only 47 forms, G. B. Bokii distinguishes 146 varieties by taking the symmetry of the form into account: the dihedron splits into three varieties, the cube into five, and so on. All the varieties of each form are tabulated, together with the point groups in which they occur, their Miller symbols, the geometrical relations of a face to the symmetry elements, and the point

<sup>1</sup> See Donnay, J. D. H. and H. Curien (1958), *Bull. Soc. fr. Min. Crist.*, **81**, XLIV.

<sup>2</sup> Boldyrev, A. K. (1936), *Am. Mineral.* **21**, 731.

group of the face. Under "Tetragonal tetrahedron" (formerly "disphenoid"), for instance, we read:

$$\begin{array}{l} 1. S_4\bar{4} \quad hkl \perp 0 \quad \left\| \begin{array}{l} 0 \quad \angle\bar{4} \\ 0 \quad \angle\bar{4}, 2(2), m \end{array} \right. \quad C_1 \\ 2. D_{2d}\bar{4}2m \quad hhl \perp m \end{array}$$

Under 1, a face ( $hkl$ ) is neither perpendicular nor parallel to any symmetry element, but it lies at an angle to the inversion axis  $\bar{4}$ . (Under 2, it might have been useful to add the second orientation,  $\bar{4}m2$ , with Miller symbol  $h0l$ .) Forms are further subdivided on the basis of space-group symmetry. The pinacoid, which gave 21 varieties in 20 point groups according to Bokii, splits into 211 varieties in 155 space groups according to Shafranovskii. There are 1403 such structural varieties in all. The next step, in this very searching analysis, is to find out in how many structural varieties each of the 17 plane groups can occur as face symmetry. The plane group of the face is listed for every form in every space group. Statistical morphological studies of actual crystalline minerals are reported. Edge forms, for which the name *frame* has been suggested<sup>3</sup> in English, are assemblages of all equivalent edges. They are considered, under such terms as: *monogram*, *digram*, *ditrigram*, *dihexagram*, etc. An isolated pentagon-dodecahedron (formerly "pyritohedron") shows two edge forms. Edge forms split into varieties, just like face forms. As to the forms of all equivalent vertices, they remain to be studied and enumerated. The first chapter ends with a brief discussion of Mikheev's *homology of crystals*: pseudo-forms result from pseudo-symmetry. In mica, for example, the rhombic prism  $\{110\}$  and the pinacoid  $\{100\}$  simulate a hexagonal prism.

Chapter 2 deals with the relationships between crystal forms and crystal structure. Fedorov's work in this domain rests on the law of Bravais. Strangely enough the three cubic modes, corresponding to the P, I, and F lattices, which Bravais called hexahedral, dodecahedral, and octahedral modes, are here referred to as hexahedral, octahedral, and dodecahedral "structures", respectively. This nomenclature presumably expresses the fact that the reciprocal of I is F and conversely. The relations between morphology, lattice, space group, and structure are thoroughly discussed and illustrated (Bravais, Donnay-Harker, P. Niggli, Mikheev, Shafranovskii, Perdok-Hartman, etc.). Chapter 3 treats of the dependence of morphology on the conditions of crystallization. The results reported are almost exclusively Russian, with the notable exception of Pierre Curie's basic principle on the symmetry of physical phenomena. Few crystallographers in the West seem to preoccupy themselves with such questions. The last chapter contains remarks on the methods of morphological investigation of crystals with plane faces. Future volumes will describe crystals with curved faces and crystal aggregates.

This book dispenses much information that is not common knowledge in this country. An English translation would be desirable.

J. D. H. DONNAY  
The Johns Hopkins University

EINFÜHRUNG IN DIE KRISTALLOGRAPHIE, by WILL KLEBER, seventh revised and expanded edition. 418 pages, 361 figures, 50 tables, and 1 colored plate,  $6\frac{1}{2} \times 9\frac{1}{2}$  inches, cloth bound. VEB Verlag Technik, Berlin, 1963. Price not given.

The first edition of this excellent treatment of crystallography from the modern viewpoint was published in 1956 (reviewed, *Am. Mineral.* **43**, 788-9, 1958), and has been enthusiastically received, especially by scientists versed in the German language. The current edition has been greatly enlarged by the addition of 106 pages, 45 figures, 6 tables and a colored plate.

<sup>3</sup> Donnay, J. D. H. (1934), *Proc. Natl. Acad. Sci.* **20**, 327.

The author discusses present-day crystallography under four general divisions: 1) Crystal structure and crystal morphology, 2) Physical chemical crystallography, 3) Crystal chemistry, and 4) Crystal physics. In the earlier editions, physical chemical crystallography was not considered as a separate division.

The treatment is clear and the text is well illustrated. This seventh edition is a notable contribution to the literature of modern crystallography.

EDWARD H. KRAUS  
*The University of Michigan*

ERZKUNDE, by HELLMUT VON PHILIPSBORN. 247 pages, 2 illustrations,  $6 \times 8\frac{3}{8}$  inches, cloth bound, Ferdinand Enke Verlag, Stuttgart, 1964. Price not given.

This is a compact, comprehensive, and authoritative treatment of ore minerals. The description of the minerals, considered as ores by the author, includes a discussion of their morphology and their physical and chemical properties, as well as their genesis, recognition, geographical occurrences, and economic uses. In addition, the application of mining laws and the hygienic conditions involved in the exploitation of ore minerals are considered.

The author divides the ore minerals into 9 groups, as follows: 1) Ferric metallic ores, 2) Non-ferric metallic ores, 3) Light metallic ores, 4) Precious metallic ores, 5) Lanthanum, actinium, and radium ores, 6) Sulfur, selenium, and tellurium ores, 7) Alkaline earth ores, 8) Alkaline ores, and 9) Boron ores. Included in the text is a selected bibliography, and two indexes: a) Mineral and b) Geographical.

Philipsborn's *Erzkunde* should prove to be very helpful to mineralogists, geologists, and chemists, and also to all who are involved in the exploitation, processing, and uses of ore minerals.

EDWARD H. KRAUS  
*The University of Michigan*

DETERMINATION DES MINERAUX DES ROCHES AU MICROSCOPE POLARISANT, by MARCEL ROUBAULT with the collaboration of J. Fabries, J. Touret and A. Weisbrod. Paris, Lamarre-Poinat, 1963, 365 p., 5 plates, 210 figures and 5 tables. Hard-bound, French Frs.: 45.

This handsome volume replaces, although with a different emphasis and a much wider scope, the little manual entitled *L'emploi du Microscope Polarisant* published in 1946 by Léon Bertrand and Marcel Roubault. The latter, for a long time a very successful booklet for undergraduates, has been of course outdated by more than twenty-five years of rapidly developing techniques. The new book has been written for students as well as for professional geologists and engineers, in other words for all those who are required to identify minerals with a petrographic microscope in pure and applied science.

The content is classical and modern at the same time. The first part (95 pages) deals with the fundamentals of crystallography, the optical phenomena used in the microscopic study of thin sections, the description of the petrographic microscope, and the determination of the optical properties of minerals. The second part (180 pages) is a standard description of the characters of major rock-forming minerals. The third part (30 pages), dedicated to special techniques, contains an interesting and very useful summary of the use of the universal stage and modal analysis.

The book has many outstanding qualities such as: numerous tables, plates and sketches summarizing a great number of data for practical use; a well-balanced but not exhaustive list of references at the end of each chapter for further research; adequate illustration with photomicrographs of excellent quality (most of them original); and last but not

least a very imaginative use of different type-setting giving the specific data of each mineral in order of relative importance. This elaborate presentation (the result of a real research in typography), combined with an excellent paper and a convenient format, makes the book a very efficient working tool, by means of which the beginning student as well as the professional can find, at a glance, the information they require for their respective fields of interest. Perfect typographical presentation for a volume of this kind should be stressed, because it is an essential condition which determines to a large extent its usefulness.

It is strange that French editors have not yet abandoned their deplorable custom of printing non-removable advertising material (in this particular case 10 pages of it) at the end of a hard-bound volume, in favor of an attractive dust jacket which may be discarded after use. This is however a minor esthetical criticism of an otherwise efficient and attractive textbook.

A. V. CAROZZI  
*University of Illinois*

PHYSICS AND CHEMISTRY OF THE EARTH, Vol. 5, edited by L. H. AHRENS, FRANK PRESS, S. K. RUNCORN, 1964. A Pergamon Press Book, The Macmillan Co., New York, 398 pp., \$15.00.

Volume 5 of the series contains the following articles: 1) The significance of the chemical bond for controlling the geochemical distribution of the elements, Part I, by L. H. Ahrens, Department of Geochemistry, University of Cape Town, South Africa; 2) Recent information of the earth's interior from studies of mantle waves and eigenvibrations, by Bruce A. Bolt, Department of Applied Mathematics, University of Sydney, Australia; 3) Geophysical studies of rift valleys, by R. W. Girdler, Department of Geology, University of Durham, Durham City, England; 4) Geomagnetic micropulsations, by J. A. Jacobs and K. O. Westphal, Institute of Earth Sciences, University of British Columbia, Vancouver, Canada; 5) Chemical thermodynamics in mineral studies, by Hans Ramberg, Department of Geology, University of Chicago, Illinois, U.S.A.; 6) The geochemistry of the alkali metals, by Knut S. Heier and John A. S. Adams, Department of Geology, Rice University, Houston, Texas, U.S.A.

Ahrens's paper is an excellent discussion of the interrelation of bonding and geochemistry, including discussions of cationic forces and electronegativity, separation of lithophile and chalcophile elements, and effect of varying degrees of covalency.

The article by Ramberg is devoted mainly to the use of heat of formation data combined with heat capacity data and density to calculate equilibrium conditions for mineral systems.

In their summary of the geochemistry of the alkali elements, Heier and Adams discuss their general chemistry, natural isotope fractionation, the radioactive nuclides  $K^{40}$  and  $Rb^{87}$ , abundance (cosmic, meteorites, tekites), a terrestrial distribution, (volcanic rocks, spilites and keratophyres, plutonic rocks, pegmatites, metamorphic and metasomatic rocks, hydrothermal waters, biosphere) and future problems.

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STUDIES IN ANALYTICAL GEOCHEMISTRY, Ed. by D. M. SHAW. Roy. Soc. Canada Spec. Publ. 6. Univ. Toronto Press, Toronto 5, Ont., Canada, 139 pp., 1963. \$6.95.

This volume comprises a group of papers presented during a symposium on geochemistry that was part of the program of Section III of the annual meetings of the Royal Society of Canada on June 6, 1962, held at McMaster University, Hamilton, Ontario. The papers included are:

The use of trace-element geochemistry in solving geologic problems	Karl K. Turekian
Sulphur isotope geochemistry	H. G. Thode
Oxygen isotope geochemistry: thermometry of metamorphic rocks	Robert N. Clayton
Some problems of the geochemistry of fluorine	Michael Fleischer and W. O. Robinson
Application of quantitative methods in the geochemical study of granite massifs	E. H. Timothy Whitten
Statistical inference in geochemistry	Gerard V. Middleton

This is one of a growing list of books constructed of a series of independent articles that deal with subjects that have varying degrees of affinity.

Such works have become especially fashionable within the last decade and there is no doubt that some offer an excellent means of presenting timely general or "review" articles that are not generally acceptable by the scientific journals for reasons of length or because of their strongly recapitulative character. In some cases, however, the articles are not very closely related in subject material and individual readers are interested in but one or two articles in an unsorted deposit of topics. Peddling of these books thus constitutes a "tie-in" sale, commonly expensive, in which the buyer obtains a modicum of useable information in a majority of intellectually uncut pages. I am happy to report that *this* little volume contains a series of closely related papers, but other recent ones are not so circumscribed.

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THE RARE EARTH ELEMENTS, by D. N. TRIFANOV, translated from the Russian by Prasenjit Basu, translation edited by R. C. Vickery, Pergamon Press Book, The MacMillan Co., New York, 125 pp., 1964, \$3.50.

Clearly the author has had but a soupçon of geochemistry and mineralogy, for he doesn't include yttrium with the rare-earths (scandium also is excluded). The book is intended for laymen, according to the Russian editor's foreword; certainly most of the material it covers—history of discovery, classification, properties, geochemistry (8½ pages), separation and uses—can be found in a modern textbook of inorganic chemistry at an intermediate level. So, if laymen read and understand chemistry textbooks at this level, then this book achieves its intention. I personally fail to see why it should have deserved translation when so many fine (and original) Russian works on the rare earths remain untranslated. See, for example, the monograph by E. I. Semenov entitled "Mineralogy of the Rare Earths" (in Russian, Moscow, 1963, 412 pp.).

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PROGRESS IN THE SCIENCE AND TECHNOLOGY OF THE RARE EARTHS, Vol. 1, edited by LEROY EYRING. A Pergamon Press Book, The MacMillan Co., New York, 532 pp., 1964, \$17.50.

Perhaps the right hand doesn't know what the left hand is doing! Why, with this book in hand, Pergamon Press should have published the translation of Trifanov (see previous review) is difficult to understand. The list of papers and their authors are as follows: 1) Aspects of the geochemistry of the rare earth, L. H. Ahrens; 2) Mass extraction and separation, K. J. Brill; 3) The separation of rare earths by ion exchange, Jack E. Powell; 4) Liquid-liquid extraction of the rare earths, Boyd Weaver; 5) Fractionation of rare earths by liquid-liquid extraction using phosphorus-based extractants, D. F. Peppard;

6) Solution chemistry, P. Krumholz; 7) Recent Soviet research on the chemistry of rare earth complexes, D. I. Ryabchikov and E. A. Trentyeva; 8) Kristallchemie der Oxide der seltenen Erden, G. Brauer; 9) Phase equilibria studies in mixed systems of rare earth and other oxides, R. S. Roth; 10) Crystal chemistry of rare earth sesquioxides, aluminates and silicates, Israel Warshaw and Rustum Roy; 11) Structural and physical properties of alloys and intermetallic compounds, Karl A. Gschneidner, Jr.; 12) Composés minéraux et organiques, F. Gaume-Mahn; 13) Thermodynamic and magnetic properties of the rare earth chalcogenides, Edgar F. Westrum, Jr.; 14) La chimie analytique des terres rares, Jean Loriers; 15) Soviet research on analytical chemistry of the rare earths, D. I. Ryabchikov and V. A. Ryabukhin; 16) Uses and applications, Richard M. Mandle and H. H. Mandle.

Of particular interest to readers of this journal will be numbers 1, 8 and 10. Ahrens' excellent and concise summary discusses origin and abundance, abundance patterns in chondrites, controls of geochemical behavior, abundance distribution in rocks, and a comparison of the coherence of the group with other groups of elements.

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A REVIEW OF THE NATURAL RESOURCES OF THE AFRICAN CONTINENT, by UNESCO. International Documents Service, Columbia University Press, 2960 Broadway, New York 27, New York, 437 pp., 1963, \$15.00.

For the geologist this book is a grave and unexpected disappointment, for less than one half of one page deals with the mineral resources of the African continent, and this merely discusses the map of the rear pocket. This map (1:10,000,000) gives no political boundaries, but a modicum of locality names, and is merely a sprinkling of mineral and element symbols (natural gas is given but not petroleum). For what purpose it may be employed is beyond the imagination of this reviewer. Other sections *do* contain some valuable information, but it is merely of the "Who-has-been-doing-what-lately" type of reporting instead of a summary or a synopsis of the results themselves. Chapter 1 is a discussion of the state of topographic mapping of Africa (it's spotty), and a map inventory. Chapter 2, on the geology, applied geology and geophysics, discusses the geological surveys, the state of mineral investigation (it's good), geological publications, research organizations and maps. Chapter 3, by the Russian Professor G. P. Gorshkov, is entitled "The seismicity of Africa," and is informative. So is Chapter 5 on African hydrology. Other chapters deal with soils, climate, meteorology, flora and fauna. Appendix II, a list of "member States, international organizations, governmental and private organizations and experts consulted by the UNESCO Secretariat," stretches to 25 pages.

If you want information on the mineral resources of Africa this is not the book to consult.

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ECONOMIC MINERALS OF TAIWAN, by C. S. HO AND CHIN-NAN LEE. Geological Survey of Taiwan, Taipei, China, 495 pp., 6 maps (plates) in rear pocket, 32 figs., 127 tables. Price not stated.

This is a completely rewritten version of Ho's 1953 summary and is divided into two parts. The first summarizes information on the geology and geomorphology of the island (60 pp.); the second is a detailed account of its mineral resources. Herein are described: coal, petroleum, natural gas, gold and silver, iron and titanium, manganese, nickel, copper, mercury, minerals of the ceramic, glass and refractory industries, building materials, fertilizer minerals, sulfur, asbestos, talc, mica, alunite, graphite, salt, radioactive minerals (in placers and pegmatites), ornamental stone, ground water and hot springs. Where perti-

ment, each is described under such topics as geology, individual deposits, grade and composition production, mining and treatment. Location maps are numerous. References in Chinese and Japanese are also given in English.

This is clearly a first-class piece of work, complete, accurate and informative and represents an authoritative and indispensable reference.

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ROCKS AND MINERALS OF CALIFORNIA, by VINSON BROWN AND DAVID ALLAN. 2nd rev. ed., Naturegraph Co., Healdsburg, California, 120 pp. 8 color plates of minerals and rocks, 102 figs., 51 maps, 1964, \$2.95 (paper bound), \$4.50 (cloth bound).

This volume is designed for rockhounds; it makes no pretense of competing with Bulletin 173 of the California Division of Mines—"Minerals of California." Its chief departures from other similar collectors' guides lies in the color plates which are bright, fuzzy and largely non-diagnostic, and in its outline maps showing locations of mineral localities (by mineral species) on a scale of 1 inch equals 9 miles. For the professional mineralogist the cost of the work far outweighs its value.

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GEOLOGY OF JAPAN, edited by FUYUJI TAKAI, TATSURO MATSUMOTO, AND RYUZO TORIYAMA. University of California Press, Berkeley and Los Angeles, x+279 pp., 30 figures, 14 charts, 1963. (Price not given.)

This book reviews and summarizes recent work on the stratigraphy, structure, and tectonic history of Japan. An introductory chapter on the general geology of Japan is followed, systematically, by chapters devoted to each period from the Silurian through the Late Cenozoic. No pre-Silurian rocks have been positively identified in Japan. With some variation, each chapter begins with a brief summary and then reviews where pertinent, the details of stratigraphy, sedimentation, paleogeography, tectonic movements, and fossil faunas and floras. Thus the book provides an excellent summary of the geology and geologic history of Japan, but little specific reference is made in the first ten chapters to the mineralogy of the deposits under discussion.

Chapter 11, however, entitled "Pre-Tertiary Igneous Activity, Metamorphism and Metallogenesis," may be of more specific interest to mineralogists. The topics indicated under this chapter heading are treated geographically, consideration being given to the Inner Zone of southwest Japan, the Outer Zone of southwest Japan, ages of metamorphisms and igneous activities of southwest Japan, and northeast Japan. Of special interest here, are summaries of the geology and mineralogy of the Kamioka mining district (pyrometasomatic lead-zinc); the Yanahara mine (pyrite ore); the Besshi mine, one of the largest copper mines of Japan, and the Taro mine (sphalerite and galena). Another section of interest to mineralogists is one devoted to absolute age determinations on minerals from the Hida gneiss, the Ryoike granitic rocks, micas from the Besshi district, minerals from certain younger granites, and minerals from pegmatites in the Abukuma plateau.

A "Glossary of Geotectonic Terms of Japan" and a "List of Fossil Subgenera, Genera and Higher Taxa proposed through Japanese Publications" will be useful references for specialists. An extensive list of "Selected References" completes the volume.

JOHN A. DORR, JR.

*The University of Michigan*

THESE FRAGILE OUTPOSTS: A GEOLOGICAL LOOK AT CAPE COD, MARTHA'S VINEYARD, AND NANTUCKET, by BARBARA BLAU CHAMBERLAIN. Doubleday & Co., Inc., New York, 1964, xxii+328 pp., \$6.95.

This book on the geology and geologic history of Cape Cod and the offshore islands of



Martha's Vineyard and Nantucket is written in a style particularly suitable for the layman. The geology presented is both quite sound and up to date.

The author makes no claim that the book is strong on mineralogy; however, included are simple identification keys for the more common rocks and minerals found in this portion of southeastern Massachusetts. The other sections of possible interest to mineralogists, albeit short and somewhat generalized, are one on sands and their composition, and one each on two mineral industries once fairly important to this region—the salt industry of the last century, which depended on solar energy for its evaporation; and the bog-iron industry, which supported the colonies in the Revolutionary War and later supported the Americans in the War of 1812.

DONALD F. ESCHMAN  
*The University of Michigan*

Paul D. Krynine, professor of petrology and sedimentation, The Pennsylvania State University, died September 12, 1964, at Buffalo, N. Y., at the age of 63.