BOOK REVIEWS

ELEMENTS OF X-RAY CRYSTALLOGRAPHY. By Leonid V. Azaroff. 610 pages, McGraw-Hill Book Co., 1968, $15.75.

The author of this new textbook in X-ray crystallography is one of the most versatile materials scientists with specialization in X-rays. The width and breadth of his teaching and research interests are amply reflected in the scope of this book. He is one of Professor Buerger's disciples, to whom the book is dedicated. It should not be out of place to mention that the author is a prolific writer, this being his fourth book within a decade. The book is intended to provide a *complete* introduction to *all* the important elements comprising the subjects of X-ray crystallography. He is one of the few who would dare to take on such a task and the organization and content of the book testify to the remarkable way it has been accomplished.

Since this is one of the more important textbooks to appear in recent years on the subject, it seems worthwhile to briefly describe each chapter. A dozen or so problems are included at the end of each chapter. The first 4 chapters (Part I) deal with the elements of geometrical crystallography. Despite the fact that the subject matter is classical the treatment given is modern and fresh. For instance, various crystallographic projections are explained in terms of more familiar map maker's terminology in projecting the globe onto paper. In the reviewer's opinion, however a better explanation of stereographic projection is found in *Introduction to Optical Crystallography* by F. D. Bloss. Also included in Part I are plane and space groups, as well as axial transformations and derivative structures. Since most mineralogists—unlike chemists, metallurgists, or biologists—have been exposed to crystallography before taking an X-ray course, the whole of Part I may be omitted.

Part II (Chapters 5 and 6) is entitled *Physics of X rays*. Chapter 5 provides historical background on Nobelists who were awarded the prize for their pioneer work in X rays. It is a unique feature of the book and provides illuminating and stimulating reading. Bragg's law is introduced at the end of this chapter. Chapter 6 is devoted to the properties of X rays in a vein one would expect to find in a modern physics text.

Part III is on diffraction theory, occupying about 1/3 of the book. The reciprocal-lattice concept is introduced at the outset of Chapter 7, before diffraction phenomenon is discussed. The reviewer is in complete agreement with its early introduction, for as the author states, "...Approaching the diffraction of X-rays by first learning about the reciprocal lattice concept can be likened to entering a country after first mastering its native tongue." Chapters 8 through 10 develop X-ray scattering by electrons, atoms, and the unit cell in a logical fashion. The treatment is quite sophisticated for students in mineralogy. An echo of Professor Warren's lectures can be found in these pages. Some recent advances in kinematic and dynamic theories of X-ray diffraction, not commonly referred to in connection with X-ray diffraction, are covered. Other topics are: anomalous scattering, and structures of the disordered, defective and layered types. The last chapter in Part III covers the entire subject of crystal-structure analysis. Needless to say, this is a topic which cannot be adequately provided in a single chapter. Books such as Buerger's *Crystal Structure Analysis* or more recently, *X-Ray Structure Determination* Stout and Jensen, should be consulted.

Part IV, with 9 chapters, is concerned with (1) various experimental techniques, (2) descriptions of X-ray equipment, and (3) indexing and identification problems. Chapter 12 describes X-ray instrumentation (tubes, generators etc.), followed by discussion of both powder and single-crystal diffractometers in Chapter 13. The following 4 chapters give outlines on Laue, rotation, moving-film (Weissenberg and precession) and powder methods. These chapters, while not exhaustive by any means, are nevertheless well-balanced and up-to-date. For example the chapter on the powder method explains the new Fink indexing method. Especially noteworthy are some practical guides on each technique, which will be

most useful for novices. Chapters 18 and 19 are on indexing powder photographs and identification of compounds (both qualitative and quantitative analysis). X-ray fluoresence and electron microprobe analysis also are briefly explained. The last chapter of the book is on special methods, e.g. texture, particle size, and stress analyses, which are particularly valuable to metallurgists. There are 4 appendices in the book, one of which merits comment. Appendix 1 gives mathematical relations, including vector algebra, complex variables and Fourier theory. Although it takes up only 10 pages, it is very concise. The book is profusely illustrated; line drawings are attractive, graphs clear and photographs excellent. The design is attractive and a new style type is sharp and pleasing to the eye.

The reviewer has tested the adaptability of this book as a text in a one-quarter course taught last spring. Because of the time limitation, it was a difficult decision in selecting the chapters to be covered. However, if the course were for a year, the entire book could probably be covered. Successful completion of the course would make one a well-rounded X-ray crystallographer both in theory and practice. Although the book is designed for chemists and metallurgists, mineralogists will find it valuable as well. In all, the author has written a fine text on X-ray diffraction and crystallography with a lucid style characteristic of the entire book. Undoubtedly this book will be around for a long time to come.

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MINERALS, ROCKS, AND INORGANIC MATERIALS. VOLUME 1, AMPHIBOLES. By W. G. Ernst. Springer-Verlag, New York, 1968. 134 pages, 59 figures. $6.80.

The eight chapters of this small book cover the crystal chemistry, the chemical variability, and the natural and experimental phase relations of three major groups of amphiboles: the iron-magnesium group, the calcic group, and the sodic group. These three groups are somewhat gradational, but may be defined and distinguished largely on the content of the M_4 cation site occupied by atoms of Mg and/or Fe^{2+} in the Mg-Fe group, and by Ca and/or Na in 7-, or 8-coordination in the other groups. The Ca-group is defined by 1 to 2 Ca in the M_4 position, and the Na group correspondingly, by less than 1 Ca (and more than 1 Na) in M_4. These are arbitrary, but reasonable boundaries; other choices could also be argued and might be found equally reasonable.

Ernst concludes his book with the following well-stated remarks, "Our current understanding of amphibole parageneses is exceedingly limited, principally because of the inherent complexities of the problems . . . " but he goes on to note the points that have been largely cleared up by his compilation. These include the causes of the comparative rarity of ferrous iron-rich amphiboles, the causes for relative rarity of the Mg-Fe amphiboles compared with the calcium group; and the causes for the similar relative rarity of the sodic amphiboles. This is clearly the best current summary of the status of knowledge of the physical chemistry and the phase-relations of amphiboles; it points up many important additional investigations, and for that alone it is worthy of widespread recognition. It properly does not go deeply into amphibole nomenclature, for to do so without extensive discussion with other workers would only add another list of "preferred" names and definitions. The treatment is modern, generally clear, and very appropriate throughout.

The editors of the series, of which this is the first volume, are W. von Engelhardt, T. Hahn, R. Roy, J. W. Winchester, and P. J. Wyllie. This is an auspicious beginning for a series that in another context might have been tritely entitled, "Advances in. . . . " Hopefully, the plan will be continued. The editors' comment that this monograph series may remove some of the disadvantages of such symposium volumes is likely to be fulfilled.

Horace Winchell
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ELECTRON-DIFFRACTION ANALYSIS OF CLAY. BY B. B. ZVYAGIN. Plenum Publishing Corporation, New York, 1967, xvi+363 p., 64 tables, 106 figures, $19.50.

The original Russian text, first published in 1964 has been extensively corrected and updated by the author for the English edition.

This volume opens with a general introduction to the structures of layer and pseudo-layer silicates as viewed from the historical and classical concepts. It then discusses extensively the use of polyhedra and polymorphic modifications to build the two- and three-layered silicates.

The next three chapters cover the basic concepts of electron diffraction techniques and their applications to layer silicates. This section of the text is well organized, starting with basic principals of electron diffraction, a discussion of the reciprocal lattice concept as it is related to the diffraction pattern, and the determination and significance of the diffraction intensities as they are related to the layer silicate structures. Although the section on the reciprocal lattice is well done, it will undoubtedly be difficult to follow unless one is acquainted with the reciprocal lattice concept.

The difficulties are largely because of differences in terminology; this is true to a lesser extent throughout the book. Since the reciprocal lattice is the theoretical bases of the relationship between the crystal lattice and diffraction pattern, the author has used this section to bridge the somewhat ideal and theoretical clay structures to their actual observed properties. This is done by giving examples of electron diffraction patterns and of the ways they are related to the various layered silicates. This section is completed by showing how the diffracted intensity is affected by the structure and geometry of the layer silicates, and by their variations in chemical composition.

The final chapter of the book deals with several examples of experimental electron-diffraction studies of clays. These include examples of the determination of crystal structures, refining structures, "micro-diffraction" or selected-area electron diffraction, and oblique studies of the clay minerals.

For those interested in the detailed structures of the clays this book will be a valuable addition to their library for its practical, experimental and reference works. The author has brought together into one volume the results of many workers through about 1962 and has presented them in a well-organized manner. It is recognized that a number of papers have appeared in the recent literature which are not covered in this book, but the methods, techniques and applications alluded to will be of value to all interested in the structures of layer silicates.

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PHYSICAL METHODS IN DETERMINATIVE MINERALOGY. EDITED BY J ZUSSMAN. Academic Press, New York, 1967, xi+514 p., 173 figures, $22.00.

The nature of the 13 chapters in this contribution is summarized in the table, except to add that indices of authors and subjects require 27 pages. Perhaps the outstanding feature of the work is that over 1000 references to the literature are listed (not allowing for any duplications), an average of two per page.

Chapter Subject	*Authors*	*No. of Pages*	*No. of References*
General			
11. Density determination	L. D. Muller	8	33
1. Mineral separation	L. D. Muller	30	88

Analytical			
12. Autoradiography	S. H. U. Bowie	7	6
5. Electron probe	J. V. P. Long	46	140
9. Thermal	R. J. W. McLaughlin	40	211
6. X-ray diffraction	J. Zussman	74	163
Microscopy			
7. Electron	J. D. C. McConnell	36	22
3. Reflected light	S. H. U. Bowie	57	39
2. Transmitted light	I. D. Muir	72	42
Spectroscopy			
13. Atomic Absorption	R. J. W. McLaughlin	12	71
10. Emission	G. D. Nicholls	14	15
8. Infrared	R. J. P. Lyon	33	110
4. X-ray fluorescence	K. Norrish and B. Chappell	54	99

It is stated that the book is written with the laboratory research worker primarily in mind. However, whole books of more or less recent vintage deal with the subjects of many of these chapters. Therefore, the relatively brief treatments here made available probably would be of value only to the *beginning* research worker, for such beginning research workers, and for graduate students interested in one or more of these fields, this book should in general serve as a very satisfactory introduction. Quite properly the emphasis is mainly on techniques and applications, rather than on fundamental principles. The book presents a most attractive appearance and gives evidence of a superior job of editing.

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RUSSIAN-ENGLISH PETROGRAPHIC DICTIONARY. Compiled by V. G. Telberg. Telberg Book Corporation, New York, 1967, 250 pp. $12.80.

This dictionary of a special field contains many terms not found in dictionaries of a more general nature and might therefore be very useful. It suffers, however, from a lack of critical editing. For example, about 60 mineral names are included, but some of the commonest rock-forming minerals are not given, whereas such rare minerals as beaverite, jeremejevite, magnetoplumbite, miloschite, schapbachite, and zirkelite have been included.

The book was prepared from typed copy, with ample spacing (20–25 terms per page) and it is easy to read, although the book is therefore rather bulky.

Only a few mistakes of translation were noted (for example, "granite" and "granat" for "garnet," "binary granite" for "two-mica granite"), but there are a good many typographical errors. A carefully revised version is needed.

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CRYSTALLOGRAPHIC PROPERTIES OF FERTILIZER COMPOUNDS. Tennessee Valley Authority, Muscle Shoals, Alabama, Chem. Eng. Bull. 6. [1966?]. No Charge. (Available from Technical Library, T.V.A., Muscle Shoals, Ala., 35660).

The 264 compounds listed in this handbook have been characterized by petrographic examination, X-ray diffraction pattern, infrared absorption spectra, and chemical analysis. The book is primarily useful in identifying these compounds. They are described by classes, consisting of four groups of phosphates and one each of carbonates, chlorides, fluorides, nitrates, sulfates, sulfites, miscellaneous, and organic compounds.

The determinative tables are based on principal refractive index, X-ray powder pattern (3 strongest lines), and major infrared absorption bands. Auxiliary full tables of the same data include actual *ir* absorption charts; a table of occurrence, preparation, composition, and miscellaneous properties serves as index and key to the other tables.

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INTERNATIONAL MINERALOGICAL ASSOCIATION. Papers and Proceedings of the Fourth General Meeting, New Delhi, December 15 & 22, 1964. Edited by P.R.J. NAIDU and M. N. VISWANATHIAH. Mineralogical Society of India. 1967. 252 pages. $8.50 (1967).

The fourth meeting of the International Mineralogical Association, held in New Delhi in 1964, featured two topical symposia and a general session. The present volume contains sixteen papers and two abstracts from the symposium on kimberlite-carbonatites, three papers and six abstracts from the symposium on zeolites, eight papers and sixteen abstracts from the general session, and the proceedings of the general business meeting.

The greater part of the book (148 out of 238 pages) is devoted to papers delivered at the kimberlite-carbonatite symposium. The appearance of two major volumes on carbonatites, the collection of papers edited by O. F. Tuttle and J. Gittins ("Carbonatites," 1966) and the monograph by E. W. Heinrich, has unfortunately robbed this collection of papers of much of its timeliness. Several of the papers are in fact either brief summaries or repetitions of material published elsewhere. Nevertheless, several of the papers contain valuable data, not readily available elsewhere.

J. D. Dawson begins the volume with a short paper stating his hypothesis that kimberlites owe their origin to assimilative reaction between carbonatite magma and crustal granitic rocks, a relationship to which several of the succeeding papers return for comment. Thus, D. K. Bailey presents preliminary experimental data on the very important equilibrium of sanidine, dolomite, phlogopite, calcite, and vapor. Perhaps the most valuable papers in the symposium are those of von Eckermann and of Gold, presenting respectively 15 analyses of diopsidic to aegirine-rich augites from the Alnö rocks and 45 analyses of 16 different minerals from the Oka carbonatite and related rocks. Useful detailed descriptions of Canadian carbonatite complexes are given by D. D. Hogarth (Meach Lake area, near Ottawa) and June E. Rapson (Ice River area, British Columbia). J. L. Powell extends his strontium isotope study of carbonatites (Tuttle-Gittins volume) to kimberlites, and finds the data consistent with the derivation of kimberlites by hybridism of carbonatites and granites, though not definitive of that mechanism. Quon and Heinrich discuss minor-element contents of dolomites and calcites from carbonatites. Paulitsch and Ambs develop petrofabric criteria to distinguish deformation of carbonatites by recrystallization from that due purely to mechanical deformation. The papers by Heinrich and Dahlem, Wimmenauer, and Gold are short general summaries of material that has by now appeared in print in more detail elsewhere. The contents of the two papers by Wyllie and by Wyllie and Biggar, taken together, differ very little from the paper by Wyllie in the Tuttle-Gittins volume.

The three published papers from the zeolite symposium deal with cation-exchange and dehydration behavior of various zeolite minerals. F. Aumento and C. Friedlaender describe variation in cell parameters of zeolites from Nova Scotia as related to their H_2O content; Anna O. Shepard and H. C. Starkey describe an experimental study of the effect of cation exchange on thermal behavior of heulandite and clinoptilolite; and Fredrik Pipping discusses the laumontite-leonhardite relation.

Three of the papers from the general session bear witness to the importance of modern microanalytical techniques, especially the use of the electron microprobe, in the recognition and study of very fine scale heterogeneity in minerals. Watanabe and Kato describe fine intergrowths of manganese oxide minerals. Goni and Guillemin present evidence for the concentration of trace elements in imperfections in minerals. Rimsaite and Lachance present a very interesting detailed study of zoned mica, antiperthitic and lamellar plagioclases, and euxenite, in which several previously unsuspected compositional variations were revealed.

The mechanical aspects of printing and composition are quite satisfactory; the halftones are generally clear, and the book has an attractive appearance, though the quality of line drawings varies considerably from paper to paper. The quality of proofreading and editing is somewhat less satisfactory, but the misprints are not so numerous as to detract seriously from the usefulness of the volume. The index is cluttered with entries that merely repeat the table of contents, but contains enough additional subject entries to be of some use, at least if the reader is lucky enough to stumble across an appropriate entry (for example, a discussion of adsorbed ions on vermiculite surfaces is indexed only under "*structures* of alkyl-ammonium vermiculites", not under "*vermiculites*", "*micas*", "*alkyl*", or "*ammonium*").

In summary, the volume contains most of the papers presented at the carbonatite symposium, although much of the material has since appeared elsewhere in greater detail; a small part of the material presented at the zeolite symposium; and a few of the miscellaneous papers presented in the general session of the 1964 New Delhi meeting. Many mineralogists and petrologists will find the volume useful, though the serious student of carbonatites will probably rank it well below the other two recent books on that subject.

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