# BOOK REVIEWS

PROCEEDINGS OF THE APOLLO XI LUNAR SCIENCE CONFERENCE. Edited by A. A. Levinson with 17 Associate Editors. Supplement I to *Geochimica et Cosmochimica Acta*, Pergamon Press, New York. In three volumes, 2492 pages. $40.00.

Detailed presentations of the 180 papers by over 200 authors at the Apollo XI Lunar Science Conference held January 5–8, 1970, in Houston, and supplementing (with about 15 exceptions) the summaries published in *Science* **167,** 447–784 (1970). Volume 1, pp. 1–990, covers *Mineralogy and Petrology*, volume 2, p. 991–1936, covers *Chemical and Isotope Analyses*, and volume 3, p. 1937–2492 covers *Physical Properties*.

This book documents what is undoubtedly the most intensive *and* extensive assault on a single set of samples by geological science. The result will undoubtedly provide a fund of information pertinent not only for future lunar samples, but for Earth petrology as well.

With a deadline of January 30, the appearance of the monumental work at the beginning of August is in itself a tribute to editors and publisher. Under the circumstances it is perhaps understandable, although very regrettable, that the volumes are indexed (individually at that) only by author.

WILLIAM T. HOLSER

X-RAY CRYSTALLOGRAPHY. By M. M. Woolfson. Cambridge University Press, London 1970. 380 pages $13.50.

An introductory textbook, unlike an advanced treatise, requires the reviewer to evaluate how the book is written, rather than what the book contains. Such evaluation is difficult because there are usually several ways of presenting the material, so that the novice will get the maximum benefit from it. More often than not, the author's and reviewer's views are different. Once in a while, however, the method of the two coincides. The present instance is such a happy exception. Although there already exist several recent texts on X-ray crystallography, the entry of the present text is well justified by a new approach to the standard material and a new arrangement of the material.

The book is divided into 9 chapters. It begins with concise descriptions of crystal morphology, symmetry elements, crystal systems, and classes as well as space groups. This is followed by two chapters on the physics of X rays and diffraction theory. The fourth chapter is on the Fourier transform, giving some of the basic mathematics which relate to the physical principles of X-ray diffraction. I know of no other introductory book in which the subject of Fourier transform is treated in as organized, clear, and complete fashion as it is here. Chapter 5 outlines different experimental methods. Although far from being complete, the author has given an excellent summary of all diffraction methods in about 40 pages. Chapter 6 is concerned with the factors affecting X-ray intensities, such as absorption, extinction, and temperature. The next chapter deals with the determination of space groups. The inclusion of optical properties in this chapter is a fresh approach, for this important physical property of crystals is usually neglected by non-mineralogist crystallographers. In the chapter on the determination of crystal structure (Chapter 8), the author gives a well-rounded treatment to various methods, with short comments on the merits of each method at the end of the chapter. The final chapter is devoted to the refinement of both cell and atomic parameters. The book offers the student a number of well-thought-out problems (called examples) and solutions. The many original illustrations, both line drawings and photographs, are all good quality. The reader may wish to add two recent books of parallel coverage to the Bibliography: (1) *Elements of X-ray Crystallography* by Azaroff and (2) *X-ray Structure Determination* by Stout and Jensen.

Woolfson, who is now professor of theoretical physics at the University of York, England, is well known not only for his many contributions in X-ray crystallography, but also for his earlier book *Direct Methods in Crystallography*. His clear and succinct writing style enables him to include all aspects of multi-disciplined X-ray crystallography into one compact volume. In summary, I heartily recommend this excellent book as a text.

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CRYSTALLOGRAPHIC COMPUTING. Edited by E. F. R. Ahmed. Munksgaard, Copenhagen, 1970, 380 pages, $25.00.

Proceedings of an International Summer School on Crystallographic Computing, comprising about 50 papers organized under the topics: Direct Methods of Phase Determination, Automatic Interpretation of Vector Maps, Anomalous Dispersion and Isomorphous Replacement, Least-Squares Procedures, Least-squares Refinement of Parameters, Thermal Vibration, Absorption and Extinction Corrections, Organization of Computer Systems, Computer-controlled Diffractometers, Protein Programs, Fourier Techniques, Data Files, Algol, and Standard Tests.

WILLIAM T. HOLSER

VIBRATION SPECTRA AND STRUCTURE OF SILICATES. By A. N. Lazarev, I. V. Grebenshchikov. Nauka Publishing Organization, Leningrad Filial, 1968, 245 pages, 1 Rb. 86 Kop. [in Russian].

A highly modern and authoritative monograph on the use of infrared spectroscopic methods for investigations on the constitution of crystallized silicates is presented by an author who has contributed many important experimental publications on special problems in this field, specifically on the constitution of rare earth silicates. As an essential supplement to X-ray diffraction methods, infrared spectroscopic methods are indispensable for a deeper understanding of the bonding characteristics in silicate structures.

The present book is a systematic presentation of methods for the correct interpretation of vibration spectra for all types of silicates and related structures, including silico-organic compounds, specifically for the identification of complex anionic silicate configurations, and their bonding mechanisms with cations, the development of coordination groups, of phase conversions, and their lattice-dynamic conditions. Silico-organic compounds demonstrate how helpful a combination of infrared spectroscopic methods with other physical-chemical properties can be.

The present book is subdivided into the following sections:

(I) An introduction to the general theory of molecular vibration spectra, and those of complex ions in crystals, including elements of the group-theoretical methods of treating crystal subgroups (with a systematic tabulation of the Herrmann subgroups) on the basis of Born crystal lattice dynamics.

(II) Application of these theories to the structure of complex anions in silicates, and "isolated" structure groups of ortho-, pyro-, and cyclic silicate anions, combined with the calculation of vibration frequencies of such groups.

(III) Relation of vibration spectra to special complex groups in silicates with "condensed" structure units, such as infinite chains, ribbons, and layers.

(IV) Application of infrared vibration spectra to problems of the crystallochemistry of silicates, the role of hydroxyl groups, special coordination groupings of cations to oxygen anions, and order-disorder effects.

As important appendices to these four sections are:

(V) Infrared vibration spectroscopy of rare earth silicates, and their crystallochemistry, including rare-earth germanates, phosphates, and sulphates.

(VI) Infrared vibration spectra and the flexibility characteristics of the bonds Si–O–Si, and P–O–P, including the bonds in chain- and ring-forming polysiloxanes, and the mobility in oxygen bridging configurations.

Each of these sections is supplemented with a rich and highly instructive bibliography from the international literature; the entire book is well illustrated, and furnished with many numerical data tables.

The physicist or the physical chemist will find here much new information on silico-organic polymers, the relationship of which with regular silicates is supported by quantitative discussions. The mineralogist will find this monograph most welcome and stimulating and bring home to him how scarce the infrared spectroscopy literature is in framework silicates except *zeolites*. The author emphasizes the fundamental importance of paramagnetic, nuclear, and electron spin resonance methods in refinements of silicate structures.

It is highly desirable that A. N. Lazarev's book may soon appear in an accurate English translation; it merits every careful study. A translation may fill a noticeable lack in the original Russian text, namely the absence of indexes of authors, subjects, and compositions.

WILHELM EITEL
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AN INTRODUCTION TO THE STUDY OF FABRICS OF GEOLOGICAL BODIES. By Bruno Sander. Translated by F. C. Phillips and G. Windsor. Pergamon Press. Oxford and New York. 1970. 641 pages. $32.00.

To most geologists structural petrology begins with Sander's *Gefügekunde der Gesteine* published by J. Springer, Vienna, in 1930. This book included material presented in earlier papers and summarized many of the ideas on rock fabrics developed by Sander during more than twenty years' field work in the eastern Alps. These ideas became known to English-speaking geologists, as a whole, largely through the writings of E. B. Knopf—particularly through *Structural Petrology* (*Geol. Soc. Amer. Mem.* **6,** 1938) written jointly with E. Ingerson. This memoir was in no sense a translation of Sander's very difficult book, but rather a clearly written interpretation of some of Sander's (and W. Schmidt's) notions on rock fabrics and their genesis. Other workers also interpreted Sander's work in English. H. W. Fairbairn published versions in 1935, 1937, and 1942 and his *Structural Petrology of Deformed Rocks* (Addison-Wesley, Cambridge, Mass.) appeared in 1949. F. J. Turner's *Mineralogical and Structural Evolution of the Metamorphic Rocks* (*Geol. Soc. Amer. Mem.* **30,**) containing a long section on tectonite fabrics was published in 1948. Even before this date experimental study of rock fabrics had begun. D. T. Griggs (an early visitor to Innsbrück) and his collaborators have continued this work for more than thirty years.

The original German-language edition of the present work (*Einführung in die Gefügekunde der geologischen Körper*, Springer-Verlag, Vienna and Innsbrück) appeared in two volumes in 1948 and 1950. It expanded many ideas of the earlier book and included much new material. The contents of these two volumes have not been simply introduced to English-speaking readers in the same way that the contents of *Gefügekunde* were introduced by E. B. Knopf. The text is longer, the prose more intricate and the material more difficult than in the earlier book; and, in spite of many references to it in the literature and the application of many of the ideas contained in it by other workers, it is likely that few geologists not unusually fluent in German ever read a significant proportion of it. For this reason, if for no other, the appearance of an authorized English translation is indeed welcome.

The translation is handsomely printed in a single volume and Pergamon Press has

clearly spared no expense in its preparation. The original color plates showing A. V. A. of quartzites are included among the excellent illustrations, and the format as a whole has been kept commendably close to that of the Springer-Verlag edition. The translators appear to have made every effort to be faithful to Sander's difficult text. In the *Translator's Preface* they admit to free translation in places, to increase clarity: but random inspection of many passages shows that they have closely preserved the style of the original. This strict adherence to the German text, although essential in a translation of this kind, is a mixed blessing for the reader: the English text remains formidably difficult.

Since the end of the Second World War the science of structural petrology has developed most vigorously in English-speaking countries. Perhaps the most important developments have been in the experimental study of tectonite fabrics, particularly of marble and quartzite, in the refinement of X-ray methods of fabric analysis and the use of computers and better statistical methods for handling data, and in the application of analysis by spherical projection to field data from complex or repeatedly deformed regions. For obvious reasons, Sander's book touches inadequately on these topics and much of what is said is of mainly historical interest. The great importance of the book lies in the philosophic basis it lays for the whole field of structural petrology and structural analysis, and in the general, if somewhat tortuous, discussions it gives of the notion of the fabric of a solid body. This notion is not a simple one, particularly so at the time (prior to 1911) that Sander first began to formulate it, when it had to contend with the simplified models of solids current in continuum-mechanical theories. Sander was one of the first of a now large group of "materials scientists" who realized the limitations of a strictly continuum approach to problems of structure and deformation of solids. In one of his prefaces (included in the translation) Sander clearly states this point: ". . . today it is clear that a knowledge of fabrics and their changes has replaced the older, more primitive concepts of the 'body,' even in the functional analysis of behavior"; and again, ". . . The study of grain fabrics . . . helps to make clear the interrelationship of an infinitesimal method of study of a continuum, a statistical study of a discontinuum and a morphological method of approach." Sander thus firmly places himself in the path of these other investigations of the "discontinuum" who have given us, for example, the dislocation theory of crystal plasticity; and with the discontinuous nature of solids in mind he explores in this monumental volume the implications of symmetry, anisotropy and local homogeneity and heterogeneity of rocks of all kinds, and the relationship of these properties and their structural expression to the physical and chemical processes that have acted to form or modify them.

Some of the detail in the book is less important now than once it was. Sander's views, for example, on the way in which slip systems in crystals act in controlling the development of preferred orientations in tectonites, and his emphasis on the presence of "shear planes" in fabrics to explain features of fabric diagrams do not always agree with the clearer pictures of mechanics of flow given by more recent experimental work. But much of the detail is important and relevant to modern work. The collection of fabric diagrams reproduced in the book is unique in its extent and variety. Also, no one has explored adequately the implications of Sander's technique of A. V. A. to establish the spatial distributions of grains in fabrics, although these features are as fundamental as the patterns of preferred orientations themselves. And too little account has been taken of the extensive discussions in the book of growth and apposition fabrics and the rhythms in time and space commonly recorded in these. There is much in the book to interest the modern sedimentologist.

As Sander himself said of the German edition, the book is not for bedside reading. The same must be said of the translation. It is difficult and one must be prepared to read with care and patience to extract the full meaning from many passages. But, as with the mining of most rare metals, if the work is long and tiring, the reward is great. It is to be hoped that

many geologists will take the trouble to read this book and hopefully, to buy it and justify the effort and vision of the translators and publishers. Although the price is high, it is surprisingly close to the local price of the original edition, and is not too much to pay for an insight into the ideas of one of the most original minds in the earth sciences.

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MECHANISM OF IGNEOUS INTRUSION. Edited by Geoffrey Newall and Nicholas Rast. *Geological Journal, Liverpool*, Special issue No. 2, 1970, 380 pages, $7.00.

Twenty one contributions to a symposium of the same name, held at Liverpool University, 9–11 January, 1969 under the auspices of the Liverpool Geological Society. An introduction by E. K. Ustiyev of the Academy of Sciences, USSR, is followed by sections on *Field Aspects of Igneous Complexes* (5 papers), *Form and Emplacement of Igneous Intrusions* (5 papers), *Experimental Data and Generation of Magma* (5 papers), *Theory of Magmatic Ascent and Emplcaement* (5 papers), and a final discussion by N. Rast.

As an editor I can't resist commenting that the typography, design, and printing are excellent.

WILLIAM T. HOLSER

MICHEL-LEVY CHART. Published by the Geological Journal, Geology Department, University of Liverpool, P. O. Box 147, Liverpool L69, England. $31.00 per 100; $250.00 per 1000 copies.

The Geological Journal has published for quantity distribution to students and research workers a new Michel-Levy chart of mineral birefringence. The layout is conventional, with mineral data modernized from the summaries of Deer, Howie and Zussman. The chart is printed in color on a heavy glossy card, suitable for permanent reference. Unfortunately, the color fidelity is so poor that first-order red is an unrecognizable dirty brown.

WILLIAM T. HOLSER