BOOK REVIEWS

STRUCTURAL PRINCIPLES IN INORGANIC COMPOUNDS W. E. ADDISON, John Wiley and Sons, Inc. New York, N. Y., vi+183 pp. 1961, $3.25.

This book is used by its author, a lecturer in chemistry at the University of Nottingham, England, in a beginning chemistry course. We highly recommend it to all earth scientists. It deals, in simple and concise language, with the relations of atomic, molecular and crystal structures to physical and chemical properties. This subject is, even nowadays, badly neglected in chemistry teaching in the USA. Yet, to crystallographers and mineralogists, it is the most interesting part of the whole of chemistry and deserves a well-planned treatment, such as the present one.

The book begins with a chapter on the electronic theory of the atom and chemical bonding. Although no advanced mathematics are used, the treatment is qualitatively up-to-date. Indeed it is a good presentation of the minimum minimorum that all scientists should have on this subject. The second chapter describes four different approaches to the study of structure: spectra, diffraction, magnetic measurements, dipole moments. The treatment is adequate although brief. As a crystallographer, the reviewer can offer a minor improvement for a future edition: a better definition of the "lattice" (p. 34)—the three-dimensional array of points that is the geometrical expression of a translation group; "lattice planes" will then not be confused with "atomic planes," nor crystal lattice with crystal structure. Also, in the discussion of neutron diffraction, the determination of magnetic structures should be mentioned.

An excellent discussion of close packing precedes the description of several simple structure types (Chapter 3). Five types are given for compounds AB, five for AB_2, three for AB_3, and two for A_2B_3. Ternary compounds, $A_xB_yC_z$, are represented by four minerals: perovskite, ilmenite, olivine, and spinel. The nineteen types selected are well chosen: nobody working with crystals could afford not to know them. A chemical classification of the compounds that crystallize in these structure types is presented next. Electronegativity of constituent elements and its effect on bond types are discussed for the various compounds; the isoelectronic rule (compounds with the same number of electrons tend to have the same structure) is given; the significance of the radius ratio is brought out. The student should now be able to derive a reasonable, though not necessarily the correct, predicted crystal structure for any compound that has predominantly ionic bonding.

Chapters 5, 6 and 7 deal with covalent structures; those in which p or s electron shells only are involved in the bond formation of the central atom in the molecule; those in which d electrons are involved; structures of polynuclear molecules and ions and those crystal structures without discrete molecules or ions, like the silicates. Again, although a staggering amount of material is covered in 57 pages, we are not overwhelmed with detail. "Electrons repel each other" still covers much, although no longer all of our knowledge of covalent bonding! The directions taken by the various numbers of electron pairs are given and discussed in detail with examples; hybridization of orbitals, σ and π bonding are explained. Chapter 6, which deals with the structure of compounds of the transition elements, has such an exemplary introduction to Ligand Field Theory, that it alone is worth the price of the book. Of all the chapters, Chapter 7 covers the material with which mineralogists will be most familiar. Yet here too, the semi-quantitative approach of ligand field theory is instructive. Cleavage and hardness, as well as the properties of molecular sieves, are explained in terms of the crystal structures. The final chapter deals with "defects" in the crystals of formula AB, which are divided into stoichiometric and non-stoichiometric compounds. For the former, the defects are classified into Scottky and Frenkel types; they are defined and

described in some detail. For non-stoichiometric compounds the usual division into types of solid solutions is extended and the presentation is original and interesting.

Whether the reader is familiar with the subject matter or not, the reading of this paperback is a pleasure.

GABRIELLE DONNAY
Geophysical Laboratory
Carnegie Institution of Washington

GRANULOMETRISCHE UND MORPHOMETRISCHE MESSMETHODEN AN MINERALKÖRNERN, STEINEN UND SONSTIGEN STOFFEN. ERHARD KÖSTER. Stuttgart: Ferdinand Enke. 109 figs., 68 tables, 336 pages. Paperbound, DM 59; hard cover, DM 63.

This volume is one of the more ambitious of several recent works summarizing the standard techniques of "mechanical analysis." It is devoted mainly to the measurement of the size and shape of the components of gross particulate systems, both natural and man-made. Köster's emphasis is on the natural materials—sediments and soils.

The scope of the work is revealed by its table of contents. The several chapters deal with (1) classification of size grades and grade scales of natural mixtures and man-made aggregates such as mined coal (42 pages), (2) methods of grain-size analysis (95 pages), including the usual macroscopic and microscopic techniques, sieving, various sedimentation procedures, both direct and indirect, in both air and water, under the normal gravitational field and with the centrifuge, (3) morphometric methods (86 pages), a section primarily on determination of shape and roundness of both large and small fragments but including also something on surface textures, dimensional fabric and sedimentary structures, (4) sampling problems and procedures (25 pages) including collection and storage of soil and subaqueous samples, dust-collecting, lackfilm and related techniques, (5) sample treatment prior to analysis (11 pages) such as removal of cement and soluble salts, and (6) evaluation and interpretation of analyses (35 pages) with special emphasis on graphic presentation and calculation of various size parameters or statistics.

This book is basically a review of techniques, the interpretative materials being minimal. Most methods are presented without comment or evaluation so that the choice of the method is left to the reader. Although much of the material will be familiar to the experienced investigator, some of the methods, especially those used in morphometric analysis, will be unfamiliar to many. Coverage of most topics is adequate although treatment of some, such as dimensional fabric, directional structures, and statistics, is very brief in view of current interest and knowledge of these subjects.

The book is well printed in a conservative format. The references to the literature, set in a rather inconvenient manner, are all collected together in the back of the book. The bibliography contains over 700 references to both the American and European literature—with only a few citations to the Russian literature. An author index (over 600 entries) and a subject index are included.

F. J. PETTIJOHN
The Johns Hopkins University

ANALYTICAL CHEMISTRY OF NIOBIUM AND TANTALUM. Ross W. MOSHIER. Pergamon Press. Distributed by the Macmillan Company, New York 11, N. Y. 1964, 278 pp., $12.75.

In this age of exponential expansion of the technical literature there is a continuing need for comprehensive reviews that periodically summarize progress and serve as take off points for further advances in knowledge. In analytical chemistry there are a number of

monographs that summarize progress in the analytical techniques themselves, but as yet there are too few monographs that summarize knowledge on the application of the newer analytical techniques to the individual elements. The last book to be devoted exclusively to the determination of niobium and tantalum appeared in 1937. Although there have been a number of review articles and individual chapters on the earth acids in books devoted to the analytical chemistry of the rarer or newly important elements, there has been no comprehensive treatment of the determination of niobium and tantalum since that time.

Moshier's book classifies by technique and discusses most of the major methods published through 1961 on gravimetric, solvent extraction, and ion exchange separations of niobium and tantalum, their colorimetric determination with polyphenols, thiocyanate, hydrogen peroxide and other reagents, and procedures involving titrimetry, chlorination and volatilization, polarography, *x*-ray diffraction and fluorescence, neutron activation, and radiochemistry. Detailed procedures are presented for several methods in each classification, including the determination of impurities in niobium and tantalum metal and compounds.

The treatment is encyclopedic rather than critical and little attempt is made to compare or evaluate the various methods. The discussion limits itself to analytical procedures although a little space is devoted to history, use, sampling, extractive metallurgy, and general chemistry of the elements; portions of two pages are devoted to mineralogy. Although recent review articles may have discussed selective methods more critically and at greater depth, this work is probably the most comprehensive presently available single source of information on the determination of niobium and tantalum. Moshier has performed a major service for geochemists and analysts who may have been unable to keep abreast with the recent remarkable advances in the analytical chemistry of the earth acids.

JOSEPH I. DINNIN
U. S. Geological Survey

CRYSTAL CHEMISTRY OF LARGE-CATION SILICATES. N. V. BELOV. Consultants Bureau translation, New York, 1960, 162 pp., $14.50.

This is the long awaited translation of a series of articles by N. V. Belov and co-workers, on Belov's exposition of "chapter two" of silicate crystal chemistry. The "first chapter" of silicate crystal chemistry is defined as that which deals with silicates with "small" octahedrally coordinated cations, in which an octahedron edge is commensurable with a tetrahedron edge. This is the "chapter" that concerns itself with the classic Bragg classification of silicate structures. The "second chapter" is concerned with silicates with large cations, with polyhedron edges spanned by Si_2O_7 groups, the basic building block of this chapter. The importance of the classification lies in the recognition that the arrangement of silicate tetrahedra is principally determined by the relative size of other cations present.

These views on strict geometrical crystal chemistry are brought out in sections containing a review of the structures of silicates containing large cations, principally those determined in Russian laboratories. The idea that the Si_2O_7 unit is the basis of the "second chapter" is first developed, and then expanded, to show that it is the basis for more complex silicate structures containing chains, ribbons, and other units. Special attention is given to calcium silicates, metasilicates, and molecular sieves. The bulk of the book is taken up with translations of the reports of structure determinations on which the "second chapter" is based.

Much of what is found in this translation is available in part elsewhere. In addition, little mention is made in this work of contributions made by others, such as Liebau. However, the aim of the collection of articles is merely to bring together in one place the ideas on silicate crystal chemistry of Belov and his school. Some workers may find some geometrical

interpretations too rigid. In some instances, such as in the case of the rhodonite structure, the data are incorrect. However, the principles of the second chapter form a viewpoint of silicate crystal chemistry which often is not appreciated, particularly in this country, and this book will be invaluable in promoting these ideas.

DONALD R. PEACOR
The University of Michigan

THE CHANGING SCIENCE OF MINERALOGY. CORNELIUS S. HURLBUT, JR. AND HENRY E. WENDEN. D. C. Heath and Co., Boston, 1964, 117+x, $1.32.

This short book has two intentions: first, to acquaint the reader with the idea that mineralogy is a materials science, allied closely with other quantitative sciences; and second, to convince him, using this background, to consider seriously mineralogy as a field of vocational interest. Chapter 1, "A Visit with a Mineralogist," is concerned with dialogue between a pre-college student and a "devoted" professor of mineralogy. His explanations of the nature of modern mineralogy serve as a springboard for the bulk of the text, which is an elementary exposition of topics such as symmetry, structure, crystal chemistry, and mineral synthesis, many of which are not included in some elementary textbooks.

The "reader," ideally, should be a gifted pre-college student, and the book is an attempt to capture his interest rather than lose him to the more familiar fields of physics, chemistry, or other materials sciences. Although the one chapter of dialogue is not up to the standards of the best literature, the point is well made, and this book should serve well to acquaint the amateur mineralogist with a feeling for the principles of mineralogy.

DONALD R. PEACOR
The University of Michigan

AN INTRODUCTION TO CRYSTALLOGRAPHY, Third Edition. F. C. PHILIPS. John Wiley and Sons Inc., New York, N. Y., 1964, pp. x+340, 535 figures, $6.00.

The third edition of this excellent book is essentially identical to the previous edition (reviewed *Am. Mineral.* **42**, 435, 1957) except that three short appendices have been added. The appendices are: (1) Two-circle and three-circle goniometers (four pages); (2) The gnomonic projection (three pages); and (3) Symmetry of pattern (eight pages).

A. A. LEVINSON
Gulf Research & Development Co.