

mented, if not particularly new. Chapter 15, on the boron hydrides, has been almost entirely rewritten by the translators, with curious results. Historically, Syrkin and Dyatkina were among the first authors to revive the bridged structure for diborane and related molecules, and their views on the electronic structure of the bridge are clearly not entirely acceptable to the translators, who give prominence to Pitzer's subsequent ideas, and ignore altogether the extension of the bridge theory to beryllium and aluminium borohydrides. The effect is confusing, and the altered chapter has lost in clarity what it may have gained in modernity.

The more theoretical chapters are not quite so good. It is, of course, wellnigh impossible to do justice to the wave mechanics of atoms and molecules in 140 pages without oversimplifying or passing over the mathematical and physical difficulties. One must admire the ambitious attempt of the authors to do this, and much of the fundamental theory—for instance, the exclusion principle and the variation method—is well explained. But surely some mention should have been made of the fixed-nucleus approximation, and the fact that the *Aufbauprinzip* is only an approximation, even for atoms?

Chapters 5 and 6 show up the resonance theory at its worst, though this does not seem to have been the intention of the authors. We now know that the 'unexcited structures' of large aromatic molecules make scarcely any contribution to the ground state; and counting resonance structures is a theoretically unjustifiable procedure. Also, the theory of ionic-covalent resonance, in its simple form, has not stood up to recent critical examination, and can no longer be taken very seriously. These last two criticisms, however, are mainly based on work which has been done since the book was written, and can hardly be laid at the door of the authors. Chapter 7 has been added in translation, and is a good chapter in its own right, though, as one might have expected, it is not particularly well integrated into the rest of the book.

The printing is good, and the translation intelligent, though it is regrettable that Mulliken's name should have been misspelt every time it is mentioned—more than twenty times.

Taken as a whole, the book is an important contribution to the literature, and is to be recommended to everyone interested in molecular structure.

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**X-ray Identification and Crystal Structures of Clay Minerals.** Edited by G. W. BRINDLEY. Obtainable only from the General Secretary, Mineralogical Society, c/o Geological Society, Burlington House, London W. 1, England; or Prof. R. E. Grim, Department of Geology, University of Illinois, Urbana, Illinois, U.S.A. Pp. 345 with many figures and tables. London: Mineralogical Society (Clay Minerals Group). 1951. Price 35s.; \$ 6.

This important work consists of some fourteen chapters by eleven carefully selected contributors. Every effort

has been made to give a balanced account of theory, methods and results for the different groups of clay minerals. The success attained in securing uniformity of treatment without suppressing the individuality of the contributors is remarkable, and great credit must be given to the editor for this achievement. The particular combination of qualities which have enabled him to do this are clearly seen in the first chapter, which presents a general survey of the structures of clay minerals and of X-ray methods used in their investigation. Where other methods give results bearing upon these problems, they are briefly discussed. Breadth of view combined with precision in detail shows itself throughout this introductory chapter and sets the standard for the whole work.

The second chapter, also by the editor, gives detailed consideration to the kaolin minerals, using this term to include structurally related species whose connection with the kaolins has only recently been traced. Thus, in addition to kaolinite, . . . , nacrite, dickite and the various forms of halloysite (including a new fireclay mineral), we find an account of chrysotile and antigorite, cronstedtite, amesite and chamosite. This is the editor's special field of study, and although the structural situation is far from simple his clarity of style brings the whole into sharp focus.

The next chapter, by Richardson, treats briefly of the phase changes which occur on heating kaolin clays. It will be of especial interest in ceramic applications.

The fourth chapter, by MacEwan, the longest in the book, treats of the montmorillonite group. Here the variables are exceedingly numerous, since, in addition to lattice proxying, we have a variable *c*-axis spacing in which diverse exchange cations and many polar organic compounds can be accommodated. As an aid in X-ray identification the author recommends the use of polyhydric alcohols and gives a number of tables useful in the analysis of mixtures of clay minerals.

The following chapter, which deals with the mica clay minerals, is divided into two parts. The first, by Grim & Bradley, is an expression of the viewpoint of the Illinois group and emphasizes the relationship of the illites to the muscovites on the one hand and the mixed layer minerals on the other. Differential thermal analyses as well as X-ray data are used in these comparisons. The second part, by Brown, gives a detailed classification of the hydrous micas, with graphical illustrations of the way in which details of the lattice may be deduced from the X-ray line intensities.

Chapter vi, by Brindley & Robinson, deals in considerable detail with chlorite minerals. Variations in basal spacing with chemical composition are shown graphically.

The vermiculites, discussed by Walker in the following chapter, seem likely to assume increasing importance in soil science. Methods of distinguishing between these minerals, those of the illite group, and the montmorillonites, are discussed. The fascinating problems of the interlayer water and the exchange cations are fully treated.

The two succeeding chapters, sepiolite by Mlle Caillère and palygorskite-attapulgitite by Mlle Caillère & Henin, provide good summaries of the information available on these fibrous minerals.

The tenth chapter, by Rooksby, deals with X-ray and thermal data on the oxides and hydroxides of iron and aluminum. This is likely to be of especial interest to those concerned with lateritic soils and similar materials.

Then follow two chapters of a more highly mathematical nature which attempt to clarify, as far as is possible at this time, the way in which X-ray diffraction is affected by random interstratification (Brown & MacEwan) and by random displacement (Brindley). These are essentially research material for the specialist; but all who try to interpret X-ray results on mixed clay materials will need to ponder their implications.

A brief and useful chapter on X-ray diffraction from non-clay minerals by MacEwan will prove extremely helpful to soils workers.

Finally, Brindley & MacEwan sum up the general situation as regards the interpretation of the composite X-ray powder diagram, having especially in mind the conclusions drawn in Chapters XI and XII. It is very clear from this discussion that the authors do not regard present-day methods as fully quantitative in the analysis of naturally occurring mixtures. How far one can go in improving the situation by careful fractionation according to particle size (vide the Wisconsin work) or by other types of preliminary treatment is not immediately apparent. Evidently much remains to be done, and the authors warn against an easy optimism. A more complete discussion of the quantitative work already attempted would have been well justified.

It is hardly necessary, in conclusion, to list all the applications which this book will foster and advance. It is evidently of great value to soil scientists, mineralogists and ceramists and in many related fields of application. Probably only those who, like this reviewer, have labored for years without such a critical digest can fully appreciate its value.

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**Selected Topics in X-ray Crystallography from the Delft X-ray Institutes.** By J. BOUMAN. Pp. xv+375, with 193 figs. and 23 tables. Amsterdam: North-Holland Publishing Co. 1951. Cloth bound. Price f. 38; 76s.; \$11.00.

This volume is the third of the *Monographs on Theoretical and Applied Physics*, edited by J. de Boer, H. Brinkman and H. B. G. Casimir. Its avowed purpose was originally to report the work done during the war in the various

X-ray laboratories of the Engineering School in Delft. The scope of the book was enlarged, however, to include more recent contributions.

About two dozen papers are contributed by fifteen authors. Most of the material covered has already been published in various journals. The introductory chapter, by Bouman, discusses the reciprocal lattice; the reciprocal vector is, unconvincingly, given the dimension of a length. This is followed by the description of a de Jong-Bouman camera, called a 'retigraph'; a thorough treatment by van Reijen of termination effects in Fourier series; Bouman and de Wolff's 1942 results on line broadening; and a short paper, by May, on how to calculate the Cartesian coordinates of cubic face-poles in a stereographic projection. Five papers, by Bouman, Burgers, and co-workers, are devoted to crystal distortions, particularly in tin, silver chloride and sheared aluminium crystals; another, by Sandee, May and Burgers, treats 'stimulation' of crystal growth in aluminium. Three chapters, by Burgers and co-workers, are concerned with photographic emulsions (the lattice dilatation of silver bromide on exposure was *not* confirmed). Prins presents a contribution on four elements (mercury, antimony, selenium and sulphur) in the amorphous stasis. P. M. de Wolff reports on quantitative determinations, with special emphasis on errors due to absorption, and describes a multiple Guinier camera. Arlman and Goppel give a study on natural rubber. Kreger tackles biological problems (waxy coatings of plants, wax rodlets of the sugar-cane stem, starch grains) and also describes a microcamera.

The editor has tried hard to lend some semblance of unity to this hodgepodge, yet its most interesting feature is its very diversity. It shows what a progressive university can accomplish with X-ray methods in the span of 30 years (the first diffraction department at Delft was established in 1921, in the Mineralogical Laboratory). Numerous references are given; adequate indexes, by authors and subjects, are appended. The text is illustrated by good half-tones and line drawings. The craftsmanship of type setting is up to the best standards, particularly for mathematical symbols. The book is well printed, on good paper.

Some peculiar spellings are occasionally encountered (*theorem*, *aequidistant*, *secondary*, . . .). They remind us that English is not the authors' mother tongue and that we should be grateful to our Dutch colleagues for using it.

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## Books Received

*The undermentioned works have been received by the Editors. Mention here does not preclude review at a later date.*

**Theory of Groups and its Application to Physical Problems.** By S. BHAGAVANTAM and T. VENKATARAYUDU. Pp. x+274. Waltair: Andhra University. 2nd ed. 1951. Price Rs. 20.

**Compendium der Kristalkunde.** By W. F. DE JONG. Pp. xii+260, with 208 figs. and 40 tables. Utrecht: Oosthoek. 1951. Price Dutch guilders 16.50.