

## Book Reviews

*Works intended for notice in this column should be sent direct to the Editor (P. P. Ewald, Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn 2, N.Y., U.S.A.). As far as practicable books will be reviewed in a country different from that of publication.*

### **Dislocations in Crystals.** By W. T. READ, JR.

Pp. xvii+228 with many figs. New York; Toronto; London: McGraw-Hill. 1953. Price \$5.00; 36s.

Crystallographers have long realized that most real crystals are imperfect, but for several reasons the study of their imperfections, and the properties of the crystal essentially dependent on them, has lagged behind that of the perfect crystal. Recent work has shown that a useful description of many properties depending critically on the state of imperfection can be given in terms of the theory of dislocations. This class of imperfection, first postulated by those interested in the mechanical properties of crystals, plays an important role in phenomena extending far beyond this field. The first direct evidence for the existence of dislocations came, in fact, from a study of the growth of crystals. The theory of dislocations is now an established part of the science of crystals and no training in crystallography could be regarded as complete which did not include some account of it. Until recently, however, the publications on the subject were limited to original papers, reports of conferences, and reviews. Dr Read's book is the second to appear which attempts an integrated treatment suitable for the instruction of those outside the field.

As the author explains in his preface, this is primarily a text-book, especially for those using it as a text in a self-taught course. The book is in two Parts. Part I (pp. 1-135) introduces fundamental ideas, and develops the properties of dislocations axiomatically. It contains only some passing references to applications. As Dr Read says, this is the easy part of the theory. Part II deals mainly with the application of the theory to grain boundaries of small disorientation (pp. 135-211) and also, more briefly, to crystal growth (pp. 139-154). The book is thus to some extent complementary to Prof. Cottrell's *Dislocations and Plastic Flow in Crystals*, although the latter is less a text-book and more a work of reference. Both treat broadly the field of Part I of Dr Read's book and give a brief account of crystal growth. The latter then omits most of the discussion of applications given in Prof. Cottrell's book, but treats in greater detail the theory of grain boundaries.

Dr Read gives several reasons for severely limiting his discussion of applications. Of the two he selects, crystal growth receives only a brief, mainly pictorial, treatment because its quantitative development involves surface kinetics rather than dislocation theory. The theory of grain boundaries, which, of course, owes much to the work of Dr Read and his colleagues at the Bell Telephone Laboratories, is developed in some detail because he regards it as ideal for teaching dislocation theory. He chooses these two particular applications as 'the principal examples where dislocation theory has given definite predictions subsequently checked by experiment'. In crystal growth the predictions depend essentially on the properties of one or a few dislocations, and the experimental evidence is the observation of the

characteristic step patterns. In grain-boundary theory, the choice of dislocation model is, if not unique, at least very limited, and it appears that measurements of the absolute energy of boundaries of small controlled disorientation will make possible a crucial quantitative check of dislocation theory. Dr Read emphasises, however, that such a check has yet to be made (p. 196), since, although the theory is valid only for small disorientations, the experimental results so far refer mainly to larger ones, and the agreement with theory here is 'probably due in part to a fortunate cancellation of errors' (p. 193). Again because of the limited choice of model, experimental and theoretical study of the motion under stress of small-angle boundaries promises to be a fruitful tool in the study of deformation. Dr Read's limited discussion of applications is also motivated by an anxiety to avoid reviewing speculative theories which cannot as yet be experimentally tested. Another criterion for limiting the field of discussion has been whether the subject is adequately treated elsewhere. Discussion of strain ageing and its ramifications (another example where a definite prediction has been made with success) is excluded for this reason. His aim has been to give the student and prospective researcher a sound foundation that will help him to attack the more difficult problems of physical metallurgy. In this he succeeds admirably. By so restricting his applications, however, Dr Read has given the book a certain lack of balance, and in his anxiety to avoid discussing speculations he has done less than justice to the theory. Much recent work omitted or given only brief reference by Dr Read, although often inspired by some attempted application, is really of the kind treated by him in Part I—namely the further development of the properties of dislocations. It is, moreover, probable that many of the problems of most practical interest are so complex that the kind of quantitative comparison of theory and experiment which Dr Read hopes for in studies of small-angle grain boundaries will be very difficult to achieve. Yet it remains true that the study of dislocation theory has already enlarged our understanding of them, and suggested powerful tools for their further study—for example, that of 'marking' dislocations by the segregation of impurities to them. This study cannot fail to assist in determining the important variables and in bringing the processes more under control. The reader wishing to learn something about dislocations, but who is at the same time more interested in applications, will thus find Part I very helpful, but will probably be disappointed with Part II.

While, as has been indicated above, issue may be joined with Dr Read over his decisions of policy, there is little to criticise in the execution of the work, which is almost uniformly excellent. The axiomatic treatment of Part I and the discussion of crystal growth in Part II is presented very clearly with a minimum of mathematical argument and is easy to read. It is ably illustrated by good diagrams, although the reproductions of photographs of growth spirals are poor. In Chapter 3, where the funda-

mental concepts of 'good' and 'bad' crystals are introduced, the discussion is, unfortunately, sometimes confusing. It is implied (pp. 32, 33) that the disordered atoms within a closed surface surrounding a dislocation line *can* be replaced by 'good' material, although the imperfection is not thereby removed. But if the dislocation remains, so does the bad material near its line, so that the replacement postulated has not, in fact, been carried out. Indeed, it seems to the writer that this replacement cannot be made when the imperfection is a dislocation. All that can be done is to set up a one-to-one correspondence between atoms in an ideal crystal and those of the real crystal in regions where the latter is *good*. The repeated use in Chapter 7 of proper names as adjectives to distinguish different kinds of imperfect dislocation is rather clumsy, especially when they occur in hyphenated pairs. The remainder of Part II, describing applications to grain boundaries, becomes increasingly more difficult, since the reader is being led to the frontier of advance in a selected field. A similar diversity in level of difficulty marks the many stimulating problems scattered throughout the text and collected at the ends of the chapters. This diversity is in some ways an advantage as it makes the book of interest to a wide circle of readers. It also ensures that the conscientious student using the book as a text in a self-taught course, as Dr Read plans, will be well grounded in dislocation theory if he survives all the problems.

Readers will need to bear in mind that in this textbook no particular effort has been made to trace historical origins, so that current references are sometimes incomplete. There is, however, a comprehensive bibliography of general works on dislocation theory at the end of Chapter 1.

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**Spezielle Mineralogie auf geochemischer Grundlage.** By F. MACHATSCHKI. Pp. vii+378 with 228 figs. Vienna: Springer. 1953. Price S. 215; DM. 36.00; \$8.60; S.fr. 37.00; 61s. 6d.

The genetic approach to mineral classification revealed in this book follows in general pattern that developed in Angel & Scharizer's *Grundriss der Mineralparagenese* (1932)—a pioneer effort to which Machatschki himself pays tribute in his preface.

In the short introduction and in the appendix, the method of treatment of mineral formulae is set out rather on the lines introduced by the author himself in 1932. The coordination of atoms or groups is indicated by superscript numbers, polyatomic anions represented in square brackets and structures based on chains, sheets and networks prefixed by  $\infty^1$ ,  $\infty^2$  and  $\infty^3$  respectively, the formula itself being followed by an abbreviation indicating the system of crystallization.

These very useful devices serve to present a condensed picture of the chief structural features of minerals. There follows a brief chapter on geochemistry, the first minerals to be described therein being somewhat surprisingly the gases of the atmosphere and water and ice of the hydrosphere.

The scope of the main portions of the book can be summarily indicated by the headings of the chief sections: the primary magmatic minerals roughly in their supposed order of crystallization; the epimagmatic minerals, including the pegmatitic-pneumatolytic and the hydrothermal; the minerals of weathering and sedimentation including clays, lateritic products, evaporites and organic minerals; and following thereon the minerals of metamorphism.

A special section (74 pp.) is devoted to the ore minerals.

It is evident that difficulties would be met in following such a scheme to its logical conclusion, and the author deliberately departs from it on occasion without, however, seriously detracting from the unity of his approach.

In the section on ore minerals the geochemistry of the single elements concerned is presented as an introduction to the description of the individual minerals, a scheme which might well have been attempted in some other sections of the book, as, for example, in the treatment of the pegmatitic-pneumatolytic minerals.

In the appendix a crystallochemical mineral system is set out in tabular form, minerals being classified in orders and families, the formulae of the species being indicated in the manner already set out in the introduction and supplemented by other pertinent data.

A few errors in the text have been indicated in a sheet of corrigenda supplied with the book. A number remain which have escaped attention. A few minerals have been allotted erroneous formulae, as in the case of sapphirine, kornerupine and ideal nepheline, and the localities of some rarer minerals are not always correctly indicated.

In all, Professor Machatschki has produced in this book a live and stimulating mineralogical classification and description on genetic lines; it provides a worthy successor to the volume of Angel & Scharizer, incorporating the more important advances of the intervening years, and should be welcomed by mineralogists and petrologists alike.

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**Organic Crystals and Molecules.** By J. M. ROBERTSON. Pp. xi+340 with 132 figs. Ithaca: Cornell University Press; London: Geoffrey Cumberlege. 1953. Price \$5.00; 32s. 6d.

This book is based on a course of lectures given at Cornell University in the autumn of 1951 during tenure of the George Fisher Baker Non-resident Lectureship in Chemistry.

The first two chapters give an account of the geometry and symmetry of crystals, based on the historical development of this field. The theory of X-ray diffraction is dealt with in the next chapters and includes Fourier methods, the phase problem, and the refinement of atomic parameters.

The second part of the book—the analysis of some organic molecular structures—covers in its successive chapters: early X-ray work; the structures of condensed-ring hydrocarbons—which show such striking agreement between observed and quantum mechanical values of their bond lengths; molecular arrangement and hydrogen-bonded structures; complex structures; macromolecules