BOOK REVIEWS

CLAY MINERALOGY by RALPH E. GRIM, New York, McGraw-Hill Book Company, Inc., 1953, 384 pages, 121 figures, 46 tables, Price $9.00.

This book is the most complete, authentic summary of Clay Mineralogy that has appeared. The well-known clay specialist of the Illinois Geological Survey and now Research Professor of the University of Illinois has compiled in fourteen chapters the available knowledge on many topics of interest to all who have investigated or utilized clays.

These topics include: old and new concepts of the composition of clay materials, classification and nomenclature of clay minerals, structure of clay minerals, x-ray diffraction data, shape and size of clay minerals in electron micrographs, ion exchange, clay-water system, dehydration, rehydration, and changes during heating, clay-mineral and organic reactions, optical properties, solubility, infrared spectra, density, origin, synthesis and occurrence of clay minerals.

Included among the questionable and discredited clay minerals are beidellite and celadonite. Ross and Hendrick's definition of beidellite (1945) as a member of the montmorillonite group, in which no substantial amounts of magnesium and iron are present and in which replacement of Si^{4+} by Al^{3+} accounts for the cation-exchange capacity, is given and is followed by the statement that because of past usage of the term it is believed desirable to drop it entirely in order to avoid confusion. The inclusion of celadonite among the questionable minerals is contrary to the recommendations of Ross and Hendricks (1941) and Kerr and Hamilton (1948). Time will tell whether geologists are ready to discard these terms.

The reader will find the scores of references useful in tracing the progress and the growth of the available knowledge on each subject. The footnote references make it possible to consult the original papers and to credit the contribution of each investigator. However, this reviewer found no reference to the original paper (1928) on the discovery of the only anauxite in the United States listed in this book or to the description of the Ione formation of California (1929) from which specimens of this anauxite were furnished for several of the investigations mentioned.

Some students of igneous petrology may disagree with the final sentence of the book, "There seems to be no reason why the clay minerals could not be formed directly in some igneous rocks," and with his previous suggestion " . . . that some clay minerals can occur as primary igneous components." The occurrence of clay minerals in the spherulites of a rhyolite from Sardinia and "late magmatic" clay minerals in a lamproite from West Kimberly, Australia, raises the question of their formation by deuteric, hydrothermal, or even weathering processes acting on unstable compounds formed in these situations rather than being true "igneous clay minerals" as the section heading indicates. That Professor Grim appreciates these possibilities is suggested by his statement: "It is manifestly difficult to distinguish with certainty between clay minerals of hydrothermal origin and those of possible igneous origin."

Students of sedimentation will learn that "glauconite is a rather unique illite type of clay mineral that is formed during marine diagenesis." Geologists will find of special interest the sections on soils and weathering, clay minerals of hydrothermal origin, recent and ancient sediments and the selected chemical analyses in the appendix.

Professor Grim and the publisher are to be congratulated on this significant book, in which the reproduction of electron micrographs of Kerr and Bates is excellent and in which typographical errors are almost absent. The reviewer recommends this book to mineralo-

gists, geologists, soil scientists, ceramicists, and engineers, as a valuable and useful contribution to the literature on clay.

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SELECTED PETROGENIC RELATIONSHIPS OF PLAGIOCLASE, by EMMONS, R. C., *Editor* (1953), *Geol. Soc. Amer., Mem.*, no. **52**, pp. x+142, 16 plates, 38 figures, and 11 tables. $2.00.

This memoir contains the following chapters:

(1) Selection and preparation of samples, by R. M. Gates and S. E. Clabaugh, pp. 5–10.
(2) Chemical analyses, by R. C. Emmons, pp. 11–22.
(3) Feldspar optics, by R. M. Crump and K. B. Ketner, pp. 23–40.
(4) A twin zone relationship in plagioclase feldspar, by R. C. Emmons and Virgil Mann, pp. 41–54.
(5) Petrogenic significance of perthite, by R. M. Gates, pp. 55–70.
(6) Petrogeny of the syenites and nepheline syenites of central Wisconsin, by R. C. Emmons, pp. 71–88.
(7) Genetic and radioactivity features of selected lamprophyres, by R. C. Emmons, C. D. Reynolds, and D. F. Saunders, pp. 89–100.
(8) A mode of evolution of a granitic texture, by Charles Bradley and E. J. Lyons, pp. 101–110.
(9) The argument, by R. C. Emmons, pp. 111–117.

Certain criticisms apply to the nine papers as a whole. The bibliography lists few of the many important papers on this subject, which is all the more unfortunate in view of the fact that many of the conclusions offered contradict and reject careful studies by other workers. Throughout much of the memoir, the organization of subject matter is confusing and makes for difficult reading. In many places it is not clear which statements are observation and which are interpretation. Supporting field evidence is not adequately detailed.

Chapters 1 through 3 comprise a single unit, and they form the most interesting and valuable part of the memoir. As the authors state, "The aim of the initial phases of this feldspar study was to extract pure plagioclase fractions of uniform composition, representing the complete plagioclase series, from each of a large number of normal plutonic and volcanic rocks." The study is concerned with a further investigation of the relations between optical measurements and the anorthite content of analyzed plagioclases. Plagioclase feldspars from pegmatites were purposely mostly excluded from this study. Chapter 1 presents a description of the criteria for choice of samples and of the means used in separating the plagioclases from the rocks. Separates of plagioclase as free from alterations and inclusions and as homogeneous as possible were sought.

Chapter 2 opens with remarks on the known scatter of points about the Federov migration curves, the subject of several earlier papers (e.g., Barber, C. T. (1936) *Geol. Surv. India, Mem.*, vol. **68**, pt. 2) which are not cited in this memoir. In view of the common reporting of plagioclase compositions to the nearest 0.5% on the basis of optical data alone, Emmons' emphasis of the lack of precision in optical determinations is most timely. In addition, he argues that optical evidence of high- and low-temperature plagioclase optics is not acceptable in view of the data given in the third chapter. Inasmuch as these data consist of optical measurements of analyzed but inhomogeneous samples, Emmons' conclusion does not carry conviction, and in addition it is contradicted by recently published work of the Carnegie Institution laboratories. The remaining part of this chapter is concerned with a discussion of the 32 chemical analyses made for this study.

Chapter 3 concerns the optical measurements made on the analyzed samples, in part on the grains of the separated samples and in part on equivalent grains in thin-section. The values of indices of refraction, optical angle, and extinction angles in the (010) zone show how much variation occurs within each sample; these variations are aptly summarized in figure 6 and are much greater than any hitherto claimed. The discussion of these data, of the cautions to be heeded in interpreting them, and of the meaning of the differences within single samples is well-conceived, but incomplete. One critical point should have been stressed. It is apparent from the content of these three chapters that the analyzed samples were not homogeneous, either on the basis of optics or on the basis of specific gravity measurements. This admitted heterogeneity is emphasized by the variable optical data listed for each sample in this chapter. No firm correlations can be made between the differing optical constants of isolated grains and chemical analyses of bulk samples containing similar grains and presumably also grains of yet different optical character. Variable optical constants of plagioclase crystals of a given anorthite content to the extent claimed in this memoir cannot be convincingly argued from measurements of chemically analyzed but optically inhomogeneous samples. For the determination of optical variations between crystals of a single anorthite content, analyses and optical measurements must be made on optically homogeneous material, and preferably on single crystals. However, such data can be used judiciously for the determination of curves of optical constants useful for the identification of plagioclases, and this the authors have done.

These first three chapters deserve the reader's careful and cautious study. The authors are to be commended for this much-needed research; it is to be hoped that their studies in this realm will be continued, and that they will compare and correlate their data with the wealth of good data recorded in the literature.

Much speculation on the meaning and nature of twinning and of zoning in plagioclase crystals is contained in chapter 4. For brevity, I shall mention only three items. Polysynthetic twinning of plagioclase is assumptively stated as a late feature of mechanical origin. This thesis has frequently appeared in the literature. The possibility is not to be denied, but it is to be regretted that the authors did not see fit to repeat their reasons for accepting a mechanical origin of polysynthetic twinning.

The infrequently mentioned possibility of adjacent twin lamellae in a single crystal having different anorthite contents is argued solely on optical grounds, a basis which many claim to be insufficient. The problem is not one to be lightly dismissed; it appears in routine work all too often. A number of explanations for the asymmetrical extinction of twin lamellae have been offered, such as that it is due to distortion of the indicatrix resulting from the strain incident to mechanical twinning or that it is because the twin composition planes are vicinal forms. Perhaps more than one explanation will prove to be valid. The problem can be solved only by chemical means, and probably only by indirect chemical techniques not dependent on the nearly impossible physical separation of twin lamellae.

An argument for the thesis that mechanical twinning removes zoning and that "zoning is a prerequisite for twinning and that the untwinned plagioclase . . . is in reality unzoned plagioclase, for whatever reason, and is incapable of twinning" is difficult to evaluate solely on the limited empirical grounds offered by the authors. This thesis is the basis for many genetic arguments. A few of the photographs cited in this respect indicate that the idea may merit further investigation, but the likelihood of this point has not been convincingly established in this paper.

Gates' chapter (5) on perthites contains many observations that lead him to two principal conclusions. The sodic plagioclase of a rock is argued as having originated by exsolution from potassic feldspar. The second conclusion is that unmixed sodic plagioclase migrates to and collects in regions of low pressure. The first conclusion is well documented to the extent that reasonable evidence is offered for the argument that perthite does collect into

discrete grains in the fabric of a rock. The second conclusion, while reasonable, is not sufficiently documented or well explained, especially with respect to the causes and nature of this mechanism. These events in the history of a rock are said to be deuteric.

Chapter 6 concerns some syenite and nepheline syenite dikes along shear zones in the cupola of a granite batholith. These dikes are interpreted as resulting from the deuteric recrystallization of cataclastic material along shear zones with the addition of sodium by means of the mechanism proposed by Gates. Sofar as the syenites are concerned, the chemical analyses offered in support of this interpretation are not conclusive. An adequate evaluation of this thesis requires more knowledge of the occurrence than can be gleaned from Emmons' description.

The thesis is offered in chapter 7 that lamprophyres represent a deuteric accumulation of mafic materials from a granite in much the same fashion that perthite is argued to provide a deuteric accumulation of sodium for the formation of the syenites described in chapter 6—thus the inclusion of this paper in a memoir devoted to plagioclase. A similar behavior of uranium to that argued for the mafic materials is developed. The idea is intriguing, and has partial support in a few analyses; unfortunately the rocks called lamprophyre are not described. Too few data are presented to permit an appraisal of the hypothesis.

Chapter 8 on the evolution of a granitic texture fails to provide a single description of a complete rock texture. On the basis of a few samples (from an area in California and one in Wisconsin) of isolated "phenocrysts" of plagioclase showing possible textural and mineralogical changes from the wall rocks of granitic bodies into the central parts of the same bodies, it is claimed that the granites originated by granitization of greenstone. The argument is incomplete; much critical information is lacking; contradictory statements are abundant; and some surprising remarks are made, such as "plagioclases have developed an apparent textural breakdown, with rotation of their component parts . . . optically but without concomitant rotation physically" and "the crystal passed through a stage of viscous fluidity"! There is no adequate reason given to beg the likelihood that the phenocrysts are simply xenocrysts.

The final chapter summarizes and synthesizes the assumptions and arguments offered in the preceding chapters. Although adding no evidence, it presents an organized discussion and philosophy. A variety of interpretations will undoubtedly arise from a reading of this chapter. My interpretation is that Professor Emmons and his associates assume that all granites, except some of those in the form of dikes, are the products of granitization and that this opinion is not only a conclusion but also the assumption fundamental to all of the petrogenic writings in this memoir.

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MANUAL FOR GEOMETRICAL CRYSTALLOGRAPHY by CALEB WROE WOLFE, xii–263 pp., numerous figures, paper bound, Edwards Bros., Inc., Ann Arbor, Michigan, 1953, distributed by Geopublishing Co., 171 School Street, Watertown 72, Massachusetts, Price $4.00.

In his *Manual for Geometrical Crystallography*, Professor Wolfe stresses those aspects of crystallography that are of especial interest to the student of two-circle goniometry and crystal drawing. A very commendable feature of the work is the definition of crystal systems in terms of symmetry rather than in terms of geometry. The author has wisely chosen the Groth-Rogers crystal class names. Consistent with this he has followed, with a few modifications of dubious value, the Federov-Rogers method of naming forms. Some definitions lack rigor. For example, it would be difficult for the student to name the (*h*0*l*)

form on a crystal of the rhombic pyramidal class from the definitions of dome and sphenoid given on page 30.

The discussion of Bravais lattices is marred by certain alternative ways of outlining non-primitive cells in order to make these cells primitive; *i.e.*, it is stated that the cubic F lattice can be outlined as octahedral, and an alternative "cubic bipyramidal" cell is given for the cubic I lattice. Such cells will not " . . . completely and homogeneously partition space without omission or overlapping." From the hexagonal P lattice a trigonal cell is chosen.

Symmetry elements used in the International Symbols are discussed. Mention is made of the use of the physical properties in determining symmetry. The necessity of developing general forms during etching to determine class symmetry and the use of optical activity are not mentioned.

In the chapter on geometrical concepts in crystallography, Miller indices are treated as coordinates of points in the reciprocal lattice. The discussion of the hexagonal system is unnecessarily complicated. If a three axis reference system is used for calculations in the hexagonal system, no ambiguity exists because of the redundant axis. Thus the question of selecting a unique symbol for a zone (coordinates in the direct lattice) or for a plane (coordinates of a point in the reciprocal lattice) does not arise. If it is desirable, the proper third symbol may be added after calculations have been completed. The cross multiplication zonal calculations are given without proof. A simple geometrical proof may be given from the linear projection, if an analytical treatment seems undesirable. Likewise, the Weiss zone law is not proved.

Many practical suggestions in the use of the two-circle goniometer are given. Unfortunately, the adjustment of the instrument is not described. The one adjustment given (page 145) is geometrically unsound. The gnomonic and stereographic projections are treated in the chapter on crystal projections. Selection of the unit cell from the gnomonic projection is discussed. Crystal drawing is largely restricted to the use of the Stöber method, in which an orthographic projection on an inclined plane (axonometric projection) is derived from the stereographic projection. The reviewer would like to see a treatment of the use of the intercepts on an axial cross. The use of orthographic plans and elevations in the graphical solution of elementary problems would also be a desirable addition. The final chapter discusses twinning from Friedel's point of view.

Probably the most useful part of the book is the chapter on crystallographic calculations. It is well written and clearly discusses the procedure in the various systems. The scheme of presentation of data used in the 7th edition of Dana's *System of Mineralogy*, to which Wolfe made a major contribution, is followed.

Since Professor Wolfe states in the preface that this edition should be considered a preliminary one, the reviewer anticipates a revised edition which will eliminate the inaccuracies as well as the typographical errors. The addition of an index would greatly enhance the usefulness of the book. The figures are for the most part adequate. The fact that considerable material which is scattered through the literature is conveniently consolidated in one book increases its value. Basically, the work should be well worth while for the student of structural as well as morphological crystallography.

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PRAKTISCHE EDELSTEINKUNDE, by DR. Ing. WALTHER FISCHER. Verlag Gustav Feller-Nottuln, Kettwig/Ruhr, Germany. 187 pp., 48 figures, 3 plates, 5 tables. 1953. Paper-bound, 16.8 R.M., or $4.00.

This work is No. 3 of the series Opuscula Mineralogica et Geologia, short works in the fields of mineralogy and geology. The book is intended for both professional and amateur

lapidaries, but should have interest to the gemologist and the mineralogist as well. The experience of the author has fitted him particularly to produce such a work. He was director of the State Museum of Mineralogy and Geology, Dresden, for 20 years, and is now director of the trade schools of Idar-Oberstein, including the School of Diamond-, Gem-, and Gold-Working of that famous gem-cutting center. In addition to his own broad experience in mineralogy and gemology, the author had available to him the accumulated knowledge of the Idar gem-cutting industry and some of the master cutters of that center.

About one-half of the book is devoted to the general principles of crystallography, crystal-physics and crystal-optics and the relation of these to the lapidary art. Hardness, for instance, is given detailed treatment, particularly as it relates to grinding and polishing. Density, heat conductivity and heating effects, electrical properties, even wet-ability, are all succinctly but adequately considered.

Stress is given to optical properties as they affect the appropriate proportions and orientation of the cut gem, emphasis being given to pleochroism as it affects the color of the finished gem, a characteristic often ignored by the lapidary. The exposition of these subjects is terse and succinct, but could hardly have been better presented for the reader it is intended to reach.

The second part of the book relates to 62 gem mineral species and their varieties, synthetic stones, glass and plastics. The list of gems is up to date, including the new minerals taaffeite and sinhalite. Included in the subject on each gem are brief sections on properties, occurrence, distinguishing features and cutting. Appropriate angles and proportions are given for facetted gems, as well as the kind of laps and abrasive suitable for each mineral. Figures of crystal form together with a figure of a facetted gem in proper orientation are shown.

Five tables of the properties of gem minerals, a short bibliography, a comprehensive index and three plates complete the work.

Much has already been written for the lapidary on equipment and mechanical techniques. This is the first authoritative work on the fundamental scientific principles of the lapidary art. The book, although succinctly written, is comprehensive and authoritative. It should be of particular value and interest to the lapidary and gemologist.

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DIAMOND TECHNOLOGY—PRODUCTION METHODS FOR DIAMOND AND GEM STONES, Second Revised and Enlarged Edition, by PAUL GRODZINSKI. XXXIV +784 pp., 486 illustrations and 93 tables. N. A. G. Press, Ltd., London, 1953. Price 54 shillings 6 pence, postpaid.

This very impressive and comprehensive book is a greatly enlarged revision of Grodzinski's DIAMOND AND GEM STONE INDUSTRIAL PRODUCTION which was published in 1942. The pages have been increased from 256 to XXXIV+784, the illustrations from 183 to 486, and the tables from 32 to 93. Every endeavor has been made to bring the various subjects up-to-date. The treatment is encyclopedic in character. There are extensive references to recent scientific publications.

As technical editor of *Industrial Diamond Review* and *The Bibliography of Industrial Diamond Applications*, Grodzinski is in an unusually favorable position to produce a unique and standard work on subjects in this technical field in which many significant advances have been made during the past decade.

The book consists of 16 chapters (712 pages), a selected bibliography (3 pages), an appendix (42 pages), a name index (11 pages), and a subject index (15 pages). The general portion of the book is divided into two parts:—(I) General Manufacturing Methods, and (II) Special Manufacturing Methods. In Part I the following subjects are treated:—Tech-

nology of Machining Methods, Dividing Diamonds and Gem Stones, Bruting, General Survey of Grinding and Polishing, Grinding and Polishing Gem Stones, Grinding and Polishing Diamond, Drilling and Boring of Holes, Carving and Engraving, Diamond Powder—Its Production and Use; in Part II: Polishing Gem Stones for Jewellery, Manufacture of Watch and Instrument Jewels, Manufacture of Diamond and Sinter Carbide Dies, Industrial Diamonds—Selection and Orientation, Setting Diamond in Tools, Grinding and Lapping of Sintered Carbides, and Production of Piezo-Electric and Optical Crystals.

The volume is profusely illustrated with line drawings and half-tone cuts. Unfortunately several cuts illustrating crystallographic features are not properly oriented. The numerous tables are very helpful.

This important volume should be made available to all persons and laboratories interested in diamond technology and related fields.

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FOUR CENTURIES OF EUROPEAN JEWELRY by ERNLE BRADFORD. 226 pp., including 48 pages with 102 half-tone cuts, 7×10 inches. Philosophical Library, New York, 1953. Price $12.00.

This book is designed for lovers and collectors of jewelry. It gives a survey of jewelry in ancient times followed by detailed discussions of the developments from the 16th through the 20th centuries. There are chapters on the use of diamonds and various gemstones in jewelry; also on Cameos and Intaglios, Rings, Enamels, and Precious Metals. The History and Properties of the Precious Stones, Birthstones, and the Craft of Gem-cutting are described in separate chapters. There is a glossary, a selected bibliography, and an index.

The illustrations are excellent and the book is well printed. It is a valuable reference book.

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