BOOK REVIEWS

SOLUTIONS, MINERALS, AND EQUILIBRIA by R. M. GARRELS AND C. L. CHRIST. Pp. 450, Figs. 151. Harper's Geoscience Series, Harper and Row, New York, 1965.

This book, on a specialized branch of geochemistry interesting to many geologists, is at once a fair teaching text, a useful handbook of electrochemical values and functional diagrams, and an authoritative monograph on oxidation-reduction equilibria. The major subject is the physical chemistry of natural aqueous solutions at the surface of the earth, under conditions of constant temperature (25° C.) and pressure (1 atmosphere), so that physical geochemists concerned with the formation of minerals and rocks below the surface will find little of interest. However, the major subject is handled well and the book is highly recommended.

Solutions, Minerals and Equilibria is a revision of R. M. Garrels' *Mineral Equilibria* with additional material by C. L. Christ. It is a substantial book of 450 pages, including a useful appendix of thermochemical constants of ions (in aqueous solution), and crystalline compounds of the principal elements. Selected references are appended to each chapter, and additional specific references are given in footnotes. In several sections and topics the reference lists are slender, but in general they give the interested reader a reasonably good start into the literature.

Terms such as activity, standard state, equilibrium constant, free energy, half-cell reactions, and oxidation potential, also some equations of relationship, are discussed briefly in Chapter 1. Functional and numerical relationships of activities, activity coefficients, fugacities, standard state, and concentrations in solutions are discussed in Chapter 2 under separate sections (gases, non-electrolyte solutions, and aqueous solutions of electrolytes). Equilibria involving CO_2 and $CaCO_3$ in aqueous solutions are discussed in Chapter 3. Complex ions are discussed very briefly in Chapter 4, and less than three pages of text is devoted to the effect of temperature variations. Measurements of Eh and pH are treated more completely in Chapter 5, and the construction of two-dimensional partial pressure and Eh-pH diagrams, in Chapters 6 and 7, is outlined in great detail and with many examples. This is the major part of the useful contribution of the book. Ion exchange on solid surfaces and various membrane electrodes are discussed in Chapter 8. A brief survey of the simpler aspects of thermodynamics is presented in Chapter 9. Miscellaneous equilibria, some with two- and three-dimensional diagrams, are assembled in Chapter 10. Some of these are of real mineral systems with experimental data, and mention is made of computed and experimental results in the system Na_2O-K_2O-Al_2O_3-SiO_2-HCl-H_2O at elevated temperature and pressure. Geological applications of mineral stability diagrams are discussed in Chapter 11, the final twenty-two pages. Measured values of Eh and pH are discussed, the conditions during sedimentation of various iron and manganese deposits are postulated, and details of the complicated stability conditions of vanadium minerals in ground water are presented. One page is devoted to the Eh-pH conditions during formation of marine chemical sediments, the last three and a half pages deal with some of the conditions during formation of ore deposits, and the final paragraph of seventy words deals with the composition of ore-forming fluids.

The book as a whole is uneven in approach and treatment of topics, and in several places a revision in the order of discussion of terms would have improved the clarity, but this is understandable in a work of collaboration such as this. Thermodynamical purists will have a good stock of points to criticize in class if this book is used as a textbook. The definition of solubility on page 55 is a good example. The temptation to list sins of omission and commission is great, but at this stage in the rapid development of geochemistry, we cannot afford to reject books if they contain bad elements, but should accept them if they

contain good ones. Accordingly, we recommend acceptance of this as a useful book covering an important field of geochemistry and predict that it will be an authoritative reference for many years.

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THERMODYNAMIQUE DE BASE POUR MINÉRALOGISTES PÉTROGRAPHES ET GÉOLOGUES, by RAYMOND KERN AND ALAIN WEISBROD. Masson et C^ie^, Paris, 1964, VII+244 pages, 80 figures. 64F, paper cover.

The treatment of thermodynamics is excellent for an introduction to the subject. It provides adequate background for mineralogists, petrologists, and geologists for understanding most of the current geological literature that makes use of thermodynamics. The subject matter is entirely classical, making only passing reference to statistical mechanics and kinetics. Topics such as atomic structure, crystal structure, types of chemical bonds, viscosity, and surface tension, which form a large part of introductory physical chemistry texts, are entirely omitted. Several examples of application of the concepts developed are presented throughout the book.

Unfortunately there are many typographical errors. The more serious of these are:

P. 19, L.11 should read $y_0^3(x^2 - x_0^2) + z_0(x - x_0) + x^2(y^3 - y_0^3) + x(z - z_0)$

P. 53, eqn (29)′ should read $dG = RT\ d(\mathrm{Ln}P)$

P. 55, in legend of Fig. 12, should read $\left(\frac{RT}{P} - V\right)$

P. 70, L. 20 should read $P_F = C^{te}$, $dP_F = 0$

P. 80, L. 3 should start $(\Delta G)_T{}^P$

P. 81, L. 7 should read α en 1/degré χ en 1/atm

P. 81, L. 24 should read $\int_1^P (\Delta V)_T{}^P\, dP$

P. 127, L. 8 up should start $dS = -R\ d\mathrm{Ln}P$

P. 177, eqn. (40) should start $RT\ \mathrm{Ln}\ \frac{(1 - x_1)x_2^2}{(1 - x_2)x_1^2}$

L. 6 up should start $x_1 = \frac{Fo}{Fa + Fo}$

P. 179, eqn. (45) should read $\mathrm{Ln}K_x \sim \frac{1160}{T} + \frac{(\Delta S)}{2}$

P. 195, L. 4 up should read $G_{cal} - G_{wo} - \mu_{CO_2} + \mu_{SiO_2} = 0$

P. 221, last line should start ΔG^0_{298}

The first and second laws of thermodynamics are presented in the 4th and 5th chapters following three chapters introducing the book, symbols, conventions, etc. A few applications of geologic interest are presented at the end of the 5th chapter. Chapter 6 presents a number of mathematical relations among thermodynamic functions preparatory to the rest of the book. In the following chapter the basic rules for using thermodynamics to determine the influence of pressure and temperature on equilibrium are deduced, and these are applied to a number of problems of geologic interest in Chapter 8. Up to this point the derivations have been restricted to phases of constant composition. The next two chapters present much the same kind of treatment as in Chapters 7 and 8, but for

phases and systems of variable composition. Chapter 11 is on the law of mass action, 12 on the phase rule, and 13 on four detailed applications to geologic problems.

Because some discussion of topics of current interest is included, e.g. phase transformations at the crust-mantle discontinuity, the Korzhinskii phase rule, and partial pressure diagrams such as given in Garrels, R. M., and Christ, C., *Solutions, Minerals, and Equilibria*, this book helps to satisfy a large need. Students who wish to acquire some knowledge of thermodynamics and its geologic usefulness should be able to do so using this book; without such a text it is generally necessary to pursue a year's study of analytical chemistry as prerequisite to physical chemistry, following which further study is needed to discover how to apply thermodynamics to geologic, rather than chemical, problems. It is regrettable, however, that a chapter on Eh-pH diagrams was not included.

In addition to the errors and omissions already noted there are difficulties with a few other parts of the book. The first of these is the treatment on pp. 62–65 of directed stress. The reader is left with the impression that a vertically directed stress on a mineral grain due to the weight of the overlying rocks, produces no horizontally directed stresses. This, of course, is not the case; rigorous treatment must include the nine stress tensors.

The equation,

$$P_F = (h - h_F)\rho_F,$$

at the top of page 65 is confusing because h_F is defined as height ("hauteur"), but in fact is depth (i.e. the positive direction is downward). The next equation, $P_3=(\rho_s-\rho_F)h+P_F$, should, in the reviewer's opinion, reduce to $P_3=\rho h$ (*cf.* p. 64) when no fluid is present. However, because ρ_F remains constant as fluid is removed but P_F goes to zero, the former equation actually reduces to $P_3=(\rho_s-\rho_F)h$. Consequently, the second equation on p. 65 seems to be erroneous. (The correct equation must be derived by the use of tensors.)

A related problem is present on pp. 142–146, in the discussions of force of crystallization and Riecke's principle, and indirectly on pp. 187–188 and 215–216 in conjunction with lithostatic pressure. The Gibbs free energy, a non-directional property of matter in bulk, will change in response to variations in pressure and temperature in accordance with relations that are easily derived. It is in effect stated that a directed stress will produce a directional difference in the Gibbs free energy, but this is established only by analogy to the effect of pressure on free energy. A rigorous treatment would again require tensors.

On pp. 176–179 the importance of writing correctly the reaction, forsterite+ferrosilite $\rightleftharpoons$fayalite+enstatite, is made clear. There is not adequate discussion, however, of why ferrosilite should be designated by $FeSiO_3$ rather than $Fe_2Si_2O_6$. In view of the fact that there are two different kinds of structural sites for Fe in the mineral, the latter formula might seem the better choice. The question is thus whether ferrosilite enters the solid solution as the "monomer," $FeSiO_3$, the "dimer," $Fe_2Si_2O_6$, or as some other "polymer." The same question arises for the olivine. In view of the 2 different types of sites for Fe or Mg in this mineral, the correct choice might seem to be $(Mg,Fe)_2SiO_4$. However, the results shown in Fig. 53 indicate that the reaction should be written, $Mg_2SiO_4+2FeSiO_3 \rightleftharpoons Fe_2SiO_4+2MgSiO_3$, or $Mg_4Si_2O_8+2Fe_2Si_2O_6 \rightleftharpoons Fe_4Si_2O_8+2Mg_2Si_2O_6$, etc. (Ramberg and DeVore, referred to on p. 177, use in effect the monomer of olivine and the dimer of pyroxene.) These considerations presume the use of activity coefficients close to unity. For other choices of "polymer" the solution will appear to be very non-ideal and the activity coefficients would have to be determined before attempting any applications. This important point regarding the "polymeric" form is not discussed.

In general this book covers the field well and should prove very useful to many geologists. It will be a valuable addition to any library.

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THE PHASES OF SILICA by ROBERT B. SOSMAN. Rutgers University Press, New Brunswick, N. J., 1965, 365+x pp., $10.00.

In 1927 the American Chemical Society published Dr. Sosman's "The Properties of Silica" as its Monograph 37. That book had the subtitle "An introduction to the properties of substances in the solid non-conducting state." It served as an aid in the self education of many in the days before solid state physics or materials science had become recognized disciplines. Though long out of print, it is still the standard reference work in its field and library copies are constantly in circulation.

The 47 chapters of ACS Monograph 47 run to 855 pages. The present volume covers only the material corresponding to the first 14 of those chapters. It is strictly limited to a discussion of the subject indicated by the new title. A further volume is promised which is to be "a study of the interrelations of the properties of silica."

In 1927, according to Sosman, seven phases of pure silica were recognized. He now recognizes 22 (or 23 if melanophlogite is included) though, as explained on page 69, the number depends on what is considered to be a "difference in phase," and Frondel in 1963 recognized but eleven silica polymorphs.

Though the present volume is supposed to cover approximately the same ground as the first parts of the earlier work, it is entirely new. The increase in knowledge of structures and phase relations required this, but some material of a type not touched upon formerly is now included. There is, for instance, a chapter on "The system SiO_2-H_2O" largely based on investigations of recent years.

Though this book will probably never be replaced, the swift progress of science may not permit it to remain for long the standard reference that its predecessor has been for so many years. Apparently it has been difficult to fit in some of the latest findings. The name stishovite appears 9 times, mostly just in lists. The last mention of it is in chapter 6, where it is stated that "so little information is available about it that it will be ignored." The fact that stishovite has rutile-type structure is not stated explicitly though at one point the "6-coordination in stishovite" is mentioned and in another place it is reported that "its x-ray pattern resembles that of rutile." In the chapter on crystal structures no reference is made to recent refinements, for instance those of the low-quartz structure in 1962 and 1963. The description of the quartz structure is based entirely on the early work with bare mention of the first Fourier analyses of 1935 and 1942.

The lack of recent references in some sections is more than compensated by a gracious and admirably lucid style. Much of the material is presented in historical account and the book affords a liberal education in those aspects of chemistry, physics and mineralogy upon which it touches. The reader is offered some fascinating bits of incidental information. So a footnote on page 298 reads "I am told that the topological mathematicians, although they have successfully solved the problem of the Seven Bridges of Königsberg and the like, have not succeeded in finding a satisfactory analytical statement of right- and left-handedness." All mineralogists, not to mention chemists, ceramists and physicists, should be grateful to Dr. Sosman for the treat he has given them. We many look forward eagerly to the forthcoming volume on "the interrelations of the properties of silica."

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THERMAL METHODS OF ANALYSIS by WESLEY WM. WENDLANDT. Interscience Publishers, New York, 1964. Pp. x+424. $16.50.

Thermal Methods of Analysis, by Professor Wesley Wm. Wendlandt of the Department of Chemistry of Texas Technological College, is a most welcome addition to the Interscience Series of Monographs on Chemical Analysis, edited by P. J. Elving and I. M.

Kolthoff. The work provides a useful, up-to-date review of a number of thermal analytical procedures.

Following a brief, general introduction, three chapters are devoted to thermogravimetry. Three chapters cover differential thermal analysis. The discussion of these two methods of thermal analysis fills nearly two hundred and seventy pages, a length quite appropriate in view of the increasing importance of DTA and TGA. Five remaining chapters cover other thermal methods of study, some of which may be new to many mineralogists. Among these subjects are pyrolytic techniques, dynamic reflectance spectroscopy, and thermal analysis. The last chapter covers quite briefly a number of miscellaneous methods, including thermoluminescence, high temperature x-ray diffraction, and dilatometry.

The treatment is, at least for the major analytical methods, well balanced in the devotion of space to basic principles and theory, history of development and major references, available apparatus, and applications. Mineralogically significant substances provide a substantial number of examples, although, of course, non-minerals, especially organic compounds, are mentioned. The bibliography, while not intended to be exhaustive, is very well selected. A number of important papers that do not seem to be well known are included. The text is well illustrated with many figures, mostly from the literature. The reviewer is particularly pleased with the schematic diagrams of DTA and TGA apparatus.

The book has proved to be valuable as a text in a course in DTA and TGA taught at The University of Michigan. The fact that one hundred and fifty pages are devoted to other thermal methods has not in any way detracted from such use of the book.

While the price seems a bit high (all prices seem a bit high), the book is, I would think, an essential reference for all those interested in the field of thermal methods of analysis.

R. M. DENNING
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THE MECHANICAL TWINNING OF CRYSTALS by M. V. KLASSEN-NEKLYUDOVA. Translated from the Russian by J. E. S. Bradley. Consultants Bureau, New York, 1964. 213 pages. $19.50.

The monograph on *The Mechanical Twinning of Crystals* is the work of Professor M. V. Klassen-Neklyudova, the Director since 1939 of the Laboratory of Mechanical Properties of Crystals in the Institute of Crystallography at the USSR Academy of Sciences, Moscow, and former pupil, some years ago, of Academician A. F. Ioffe at Leningrad. While working at the Physico-Technical Institute of the Academy of Sciences, USSR, in Leningrad, he obtained the degree of Doctor of Philosophy in Physical and Mathematical Sciences, preparing in 1933 a monograph entitled "Mechanical Properties of Crystals." The general theme of his work has been in the mechanical properties of crystals and the physics of plasticity.

The treatise on *The Mechanical Twinning of Crystals* is not confined to mechanical twinning in the narrow sense (reorientation in response to mechanical stress); it also deals with many related effects, such as the formation of reoriented regions in response to high temperatures (martensite transformations, recrystallization twins), electric fields (ferroelectric domains), and magnetic fields (magnetic domains). Mechanical reorientation is discussed for classical twinning and also for an inhomogeneous distribution of residual stresses (irrational twinning, kinking, and deformation bands). He concludes with an elucidation of the macroscopic and microscopic theories of twinning. The three appendices are new additions for the English translation, each containing data obtained after the original Russian publication. Appendix I, *Selective Etching as a Means of Studying Twinning*, Appendix II, *Selective Etching Applied to the Dislocation Mechanism of Twinning with*

Change of Form, and Appendix III, *Selective Etching Applied to Twinning without Change of Form*, contain very interesting studies and observations significant in the study of the mechanical twinning of crystals. Indeed, the English translation is in a sense a revised edition of the original Russian publication, inasmuch as Professor Klassen-Neklyudova enlarged the scope of several sections, rearranged some chapters, and added new materials.

The arrangement of the material in this book provides information on each of the major aspects of mechanical twinning. There is a good table of contents with detailed headings to enable the reader to find quickly any portion of particular interest, very good illustrative material, and an adequate index. In addition, the author has furnished more than five hundred bibliographic entries which should help the reader fill in the gaps in his knowledge of the literature on the mechanical twinning of crystals. The reviewer quite agrees with Professor Klassen-Neklyudova, as stated in the foreword, that the ever increasing number of publications constitutes a great difficulty. In his words, "Many of us now find that one can either concentrate on bench work or concern oneself solely with published papers." He attempts to simplify the problem by his comprehensive bibliographic references.

The monograph is indeed an invaluable contribution to the literature on the basic laws of twinning, a fundamental tool to the understanding of the deformation and rupture of crystalline materials of all kinds.

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SPEKTRALANALYSE VON MINERALIEN UND GESTEINEN by H. Moenke. Akademische Verlagsgesellschaft Geest & Portig, K.-G., Leipzig, 1962. x+222 pages, 58 figures, 21 tables. DM 23.

The stated purpose of this book, to provide in German a reference to those techniques in emission and infrared absorption spectroscopy which are particularly valuable and necessary for the analysis of rocks and minerals, is reasonably well achieved. It is not intended as a substitute for Ahrens, (1950), Spectrochemical Analysis (nor presumably for Ahrens, L. H. and Taylor, S. R., (1961), Spectrochemical Analysis, 2nd. ed., which does not appear in the bibliography). Rather it was intended to consolidate information from many sources into one text in German, much as Ahrens had done in English for emission spectroscopy of geologic materials.

The first chapter treats emission spectroscopy, beginning with a discussion of the fundamentals. It seemed to the reviewer in reading this section that it was far too brief to impart any real understanding of the subject. This does not particularly detract from the book, however, because the intent is to discuss only the geologic application, not the theory. Following some useful suggestions from the author's experience, a brief description of equipment and procedures is presented. Discussion of special techniques, special problems, and the nature of analyses of rocks and minerals ensues. The last part of the chapter gives detailed procedures for and problems encountered during analyses for 48 elements and the rare earth group.

Chapter 2 likewise starts with a short introduction to principles of infrared absorption spectroscopy together with some comments and generalizations on their applicability to minerals. This is followed by a good summary of preparation techniques and very brief descriptions of instruments. The Jena UR 10 is emphasized in this section. A large portion of the chapter describes the spectra of individual groups of minerals, gives interpretations of the spectra, and cites relevant features of Raman spectra. The chapter concludes with 4 pages on Raman spectroscopy and 3 on quantitative infrared analysis. The impression arose during reading this chapter that probably considerable reference would need to be

made to the literature (which seems to be cited for this purpose) by anyone desiring to use these techniques. This is especially true for Raman spectroscopy, for which, moreover, many of the references are in English.

Chapter 3 presents a useful combination of the techniques treated in the preceding part of the book. Suggestions are given for potassium salt deposits, borate deposits, ores, rocks (igneous, metamorphic, and sedimentary), oil, coal, and both fresh and ocean water. For instance, for potassium salt deposits it is recommended that the minerals be identified by infrared absorption spectroscopy and the trace elements by emission spectroscopy. Throughout this chapter suitable analytical lines are listed and suitable instruments specified. A few dozen absorption spectra are given.

Chapter 4 is entirely bibliographic, listing about 650 references.

This book should be quite useful to those engaged in rock and mineral analysis by these methods who prefer a reference in German. In English speaking countries research workers will probably prefer to use Ahrens and Taylor, Spectrochemical Analysis, 2nd. ed., for emission spectroscopy and other texts for infrared and Raman spectroscopy. The bibliography is valuable in any case, and the text should be very useful for graduate students in preparation for language examinations.

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COMPLEXING AND HYDROTHERMAL ORE DEPOSITION by HAROLD C. HELGESON. Pergamon Press New York (Distributed by The Macmillan Co.), 1964. xiv+128 pages, 48 figures, 6 tables. $8.50.

The topic of this book, which is volume 17 of the International Series of Monographs on Earth Sciences, is very timely and well written. The summaries at the ends of the principal chapters present the main conclusions in a clear style that does not require extensive knowledge of chemistry. These results are carefully stated and the uncertainties are noted.

The second chapter, thermochemical parameters of hydrothermal complex formation, presents a number of generalizations regarding complex formation and stability. These principles are of far wider usefulness than the particular applications treated in the book. Generally applicable approximations for equilibrium constants and activity co-efficients at elevated temperatures are also discussed. The author derived the method for activity co-efficients during the course of this study, and adapted that for equilibrium constants from the work of Criss and Cobble (refs. 31 and 32). Both methods deserve wide recognition by geochemists. The base from which the free energy function is calculated differs from that usually found by the reviewer, but is perfectly satisfactory.

Chapter III applies the principles and methods previously discussed to a portion of the PbS-NaCl-HCl-H_2O system at elevated temperatures. Nine equilibria were chosen to give a good approximation to the solubility of PbS in a part of the system, and the corresponding mass action equations were solved simultaneously on a high speed digital computer. In spite of large uncertainties in some of the equilibrium constants very interesting and highly significant results were obtained. The conclusions drawn are so qualified as to be valid; questions arise only regarding how well these solutions simulate natural solutions. It is notable, for example, that H_2S is present only in very small amount, and is not an independent component of the system. It is also assumed in choosing the nine equilibria to study that some chemical species known to be present have negligible effects. On the basis of present data these assumptions appear to be valid, but cannot be proved.

The last chapter relates the preceding results to the geological environment. Such factors as the pH and alkali contents of solutions found experimentally to be in equilibrium

with common products of rock alteration, the composition of fluid inclusions, phase relations in the $NaCl-H_2O$ system, and geothermal gradients are taken into account.

This book presents an excellent examination of some aspects of the problems of hydrothermal ore deposition. It is fully realized that other aspects must be examined, other systems studied, and as knowledge increases changes made in the representation given. This significant work should be examined by all who are concerned with ore deposition or with complexes in natural aqueous solutions.

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OPTICAL PROPERTIES OF MINERALS. A DETERMINATIVE TABLE by HORACE WINCHELL. Academic Press. 111 Fifth Ave. New York, N. Y. 91 pp. 39 figs. 1964. $5.00.

Most of this useful little volume consists of a series of semicircular identification charts constructed to combine 2V values with values for the birefringence of minerals. There is one chart for each of several ranges of B index values (e.g. 1.300–1.399; 1.400–1.459; 1.460–1.479; thence for increment ranges of 0.019 up to 1.800; thence in increments of 0.049 to 2.199; thence in increments of 0.099 to 2.500; and one chart for >2.500). Each of these charts thus represents a horizontal slice through a hemicylindrical coordinate field with β (Ny) along the cylinder axis; $2V_z$ used as the azimuth angle defining a plane containing the cylinder axis and birefringence ($B=N_z-N_y$) represented by the radial distance from that axis. Thus in each chart the northeast quadrant is for $2V_z=(+)$, whereas the southeast quadrant covers values of $2V_x=(-)$. Individual species are plotted as numbered points and identified by number on the opposing page. Many name entries are followed by their 3 principal *x*-ray powder diffraction d values and by their card number, if any, in the 1960 ASTM X-ray Powder Data File. The importance of minerals is indicated by type styles: VERY COMMON, ordinary and *Rare*. Many common minerals of isomorphous series, have, of course, multiple listings in this scheme.

Altogether this is a most useful and useable compilation, one well worth the modest investment.

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MINERALOGY OF THE BLACK HILLS by WILLARD L. ROBERTS AND GEORGE RAPP, JR. Bull. 18, South Dakota School of Mines and Technology, Rapid City. S. Dak. (57701) 1965. iv+268 pp. $4.50 (paper), $6.50 (bound).

This is the first bulletin of this series since 1937, the second since 1929. It replaces Victor Ziegler's *Bull.* **10,** Minerals of the Black Hills, 1914. The present volume has 8 unnumbered photographic plates, 24 unnumbered line drawings, and no maps, quite in contrast to Ziegler's book, which discussed minerals according to the Dana classification. Roberts and Rapp use an alphabetical arrangement, though the brief introduction has a listing *a la* Dana. There is a very complete bibliography, and an index giving names and locations of mines.

Klockman: Lehrbuch der Mineralogie (1954) by Paul Ramdohr lists 93 "berühmte Mineralfundorte," omitting the Black Hills, though the Etta Mine is included. The present work ensures that the Hills will be listed high up in any future such compilation.

Roberts and Rapp combine a very careful literature search along with a great deal of work by the authors in the field and laboratory. The great strength of the book is in its very extensive citation of localities with verified occurrences. Descriptions of minerals are very properly kept to a minimum, and of course there is no determinative table. The type is good-sized and the book is well-printed and bound. Very few misprints were noted

(this writer's name is mis-spelled on p. 8). It is peculiar that ferberite, huebnerite, and wolframite are not put together (as are for example triphylite and lithiophilite) but appear on pages 85, 110, and 219! The amblygonite—montebrasite series is also split widely apart.

Everyone interested in regional mineralogy will wish to own a copy of this volume, and the profession owes the authors a hearty vote of thanks for their rewarding labors.

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AMERICAN GEM TRAILS by RICHARD M. PEARL. McGraw-Hill Book Company, New York, 1964. 173 pp. $5.50.

American Gem Trails by Richard M. Pearl, Professor of Geology at Colorado College, supplements and complements two of his previous books, *How To Know Minerals and Rocks* and *Successful Mineral Collecting and Prospecting*. In the preface, Professor Pearl states that this book has been twenty-five years aborning, having been conceived as a term paper in a course in economic geography in 1937! Pearl considered that amateur mineralogists and mineral collectors needed a book of modest scope and price as a guide. Forthwith, he published this small volume for the gem hobbyist and rockhound in search of America's gem stones.

The author makes no pretense of presenting a comprehensive history of gemmology or a complete description of every area where gems may be discovered. However, he has given highlights of interesting bits of romance and adventure related to gem hunting. He includes gem stones from Carolina rubies and Montana sapphires to Arizona petrified wood. For each gem stone, Mr. Pearl gives its chemical composition, mineral relationships, origin, geologic occurrences, physical aspects, and means of identification. In addition, he tells the reader how and where to find it.

The book is not flawless—few are. But for the purpose for which Pearl intended his small volume, it will prove useful. The simplicity of statement and directness of approach makes the text very easy to follow. Chapter 5 on "The Nature of Gems" is indicative of this method of presentation. Several features of the book lend interest: (1) the use of literary quotations at the beginning of each chapter; (2) the individual outline maps showing the distribution of various gem stones; and (3) the attractive photographs of mineral specimens.

Although *American Gem Trails* has no new information on gems, for the beginning mineral collector and the average rockhound, it should prove a useful adjunct.

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INTRODUCTORY SOILS by KERMIT C. BERGER, The Macmillan Company, New York, 1965, 371 p., $5.95.

This is a very introductory text designed for use in a soils course given to people with no previous training in chemistry; some of its failings stem from the fact the complex chemistry of soils can be given only superficial treatment. The book has a relatively full descriptive treatment of the several elements important as plant food and also of trace elements found in plants. It is well illustrated.

The book suffers in its over-simplification. The treatment of rocks and minerals is woefully incomplete and misleading. For example, igneous rocks are classified only into granite, diorite, and basalt, and a picture of "granite" on page 91 is actually of a well foliated gneiss. Other unfortunate aspects of the book stem from both poor expression (e.g., "windborne . . . sand particles are called dunes," and a statement that the glacial

ice which covered the midcontinent area was "more than 1000 feet thick") and from inadequate proofreading, as when "million" is written instead of "billion" in referring to the length of pre-Archeozoic time.

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SHORT REVIEWS

PHOTOGRAPHY FOR SCIENTIFIC PUBLICATION, A HANDBOOK by ALFRED A. BLAKER. W. H. Freeman and Co., 660 Market St., San Francisco, California. 158 pp., 58 illust., (2 full-color plates), $8.00, 1965. A valuable handbook for the nonprofessional photographer concerned primarily with problems of securing and preparing high-quality illustrations for scientific articles. Does not treat photomicrography; therefore nothing on problems of photography of thin-sections, polished sections or with polarized light and crossed polars. Examples are chiefly of biological materials.

CLAYS AND CLAY MINERALS. INDEX TO THE PROCEEDINGS OF THE FIRST TO THE TENTH NATIONAL CONFERENCES by THOMAS E. BRIDGE AND SYBLE BRIDGE. Pergamon Press, Inc., 44–01, 21st St., Long Island City, N. Y. 87 pp. 1965. $6.00.

KRAKATOA by RUPERT FURNEAUX. Prentice-Hall, Inc. Englewood Cliffs, N. J., 224 pp., 16 plates. 1964. $4.95. A blow-by-blow account of the 1883 eruption of Krakatoa and its aftermath. Detailed, with eyewitness accounts from contemporary records from old Javanese newspapers. Unfortunately written in a florid, bombastic, verbally orgiastic style reminiscent of the Graham McNamee style of radio reporting of the 20's and 30's.

PRECAMBRIAN GEOLOGY OF THE POPOLOPEN LAKE QUADRANGLE, SOUTHEASTERN NEW YORK by R. T. DODD, JR. Map and chart series No. 6, New York State Museum and Science Service, Albany, N. Y., 39 pp. and map (1: 24000), in color. 1965. $2.50.

MEXICAN MINING INDUSTRY by MARVIN D. BERNSTEIN. The State University of New York. The Antioch Press, Yellow Springs, Ohio. 412 pp. 1965. $10.00. A scholarly study of the economic history of Mexican mining from the end of the 19th to the middle of the 20th centuries, with emphasis on the interaction of politics, economics and technology.

SYMMETRY ASPECTS OF M. C. ESCHER'S PERIODIC DRAWINGS by CAROLINE H. MACGILLAVRY. Published for the International Union of Crystallography by A. Oosthock's Mitgeversmaatschappig NV, Utrecht, The Netherlands. 84 pp. 41 Plates (12 in color). 1965. A handsome wedding of science and art as exemplified by the periodic patterns of the symmetric tesselations of artist M. C. Escher whose drawings are excellent examples for teaching principles of symmetry. Even if you are not interested in figuring out the space groups, the illustrations, *per se*, are marvellous.

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