

BOOK REVIEWS

VOLCANIC REGIMES IN CANADA. W. R. A. Baragar, L. C. Coleman and J. M. Hall, Editors. Geological Association of Canada Special Paper Number 16, 1977. viii + 476 pages. \$18.00.

GENERATION OF BASALTIC MAGMA. By H. S. Yoder, Jr. National Academy of Sciences, Washington, DC, 1976. xii + 266 pages. \$8.25 hard cover, \$5.50 soft cover.

The image of the intrepid volcanologist, dashing off to study the fiery spectacle of an eruption, is one that excites reporters, readers of Sunday supplements, and small cousins. But the answers to some of the best questions asked by those small cousins—where does the lava come from? why is the volcano where it is?—are not to be answered at the fiery spectacle. These questions are being answered by careful laboratory studies, detailed field investigation of long-cooled rocks (in some decidedly non-fiery terrain), and in the synthesis of a large body of unglamorous work. The two books reviewed here deal with these approaches to the study of volcanism. They carry no red photographs and are unlikely to be abstracted in the Sunday supplements, but they are excellent books at very reasonable prices that belong in all good geology libraries.

The Geological Association of Canada book grew from a symposium sponsored by the Volcanology Division of that group in May, 1975. Although Canada does not spring to mind when naming the active volcanic regions of the world, unwitnessed eruptions have taken place in the Coast Range during the last 200 years, and Canada's combination of varied geology and excellent geologists has resulted in many fine studies of ancient volcanism. The richness of the Canadian volcanic record is shown by the six sections into which the book is divided: Cordilleran regime, Appalachian regime, Proterozoic belts, Archean greenstone belts, the stable crust regime, and the Oceanic regime. Each section begins with an invited 20–40-page general paper that reviews either the region or a representative portion. Taken together, these six papers provide an excellent summary of Canada's volcanic record. The remaining 17 papers were selected by the editors from twice as many submissions. They cover varied subjects of widespread geologic interest such as: volcanism–tectonism relationships, ophiolites, geochemical indicators of paleotectonic setting, granitic batholiths, ultramafic lava flows and volcanoclastics, cyclic volcanism, intrusive–extrusive comparisons, Keweenawan flood basalts, seamounts, and the Tertiary volcanics of Baffin Bay. More than one third of the volume is devoted to Archean belts, but the other five sections are roughly equal in length.

The book is attractively produced, with few typographic errors, and the more than 150 maps and diagrams are clear and well done. Several of the 19 photographic plates did not reproduce well, and the reference value of the volume would have been enhanced by an index. *Volcanic Regimes in Canada* provides both an excellent summary of an unusually diverse volcanic record and a selection of papers illustrating the varied approaches being used by the able geologists working there. Few geologists working on volcanic products elsewhere will fail to find in this volume information directly useful to them in their own work.

The origin of magma is one of geology's most fundamental questions. Treatments of volcanism commonly assume the exist-

tence of magma—if its formation is not altogether ignored, it is at least overwhelmed by emphasis on its surface behavior or the changes that produce diverse products from a pre-existing primary magma. This emphasis is easy to understand, because magma origin is substantially further removed from observation (being some 70 km or more below the surface), and its attack by high-temperature and high-pressure laboratory techniques requires more training in chemistry and/or physics than most geologists receive. However, the emphasis imbalance (at least in book-length texts) has now been improved with the welcome publication of *Generation of Basaltic Magma*.

The book began when H. S. Yoder was selected for the first Arthur L. Day Prize and Lectureship, and it grew through his series of lectures in May–June, 1975 at Dartmouth College and the Geophysical Laboratory of the Carnegie Institution of Washington (where Yoder has been Director since 1971). The author's pioneering work on basalt genesis during the last two decades equip him well for the subject, and he has further guaranteed quality by obtaining draft reviews from 20 other specialists.

The first quarter of the book deals with what (and where) basaltic magma comes from in the Earth's upper mantle, and the last quarter treats its accumulation, upward movement, and extrusion at the surface. The central half of the book deals with the melting processes that produce basaltic magma, and discusses both the major magma types and olivine in the parental material. The text ends with a 9-page summary that effectively uses questions and brings out, as does the rest of the text, the many unknowns and tenuous conclusions remaining in our current understanding of magma genesis. A useful appendix includes 23 pages of references and a 22-page subject index.

Aiming at an audience that has had no more than a general course in petrology, Yoder writes clearly and readably about a complex subject. The illustrations (118 diagrams and 2 color plates) are well chosen, the book production attractive, and the price very reasonable. All geologists interested in basaltic magma will welcome this authoritative summary of the theoretical/experimental approach to its origin.

TOM SIMKIN
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GEOLOGIE DU DIAMANT. By M. G. Bardet. Vol. I, Généralités, 1973, \$50. Vol. 2, Gisements africains, 1976, \$50. Vol. 3, Gisements d'Amerique du Sud et d'URSS, 1977, \$36. Bureau de Recherches Géologiques et Minières, Avenue de Concy, Orléans-la Source (Loiret), B. P. 6009, 45018 Orléans, France.

Geology of Diamond is a 3-volume work issued by the Bureau of Research into Geology and Mineralogy (BRGM) of France. This organization undertook geological and mineralogical exploration originally in the French Colonies but has since diversified itself to, amongst other things, major exploration projects throughout the world. Bardet has been associated with the organization much of his professional life, particularly with the group undertaking kimberlite and diamond exploration. To some extent these three vol-

umes represent the culmination of M. Bardet's professional interest.

At the outset one has to congratulate M. Bardet for the comprehensive treatment of diamond and kimberlite. The reader, however, should be aware that in many respects the text is based upon facts and rumors gleaned by M. Bardet during his tenure as diamond geologist and consultant for BRGM. Inasmuch as most companies engaged in diamond exploration are extremely secretive, M. Bardet has done science quite a service in illuminating some of these endeavors. Nevertheless, some caution must be used in reading parts of the text.

Volume I, published in 1973, deals, as its title indicates, with generalities of diamond. The table of contents is at the back, rather than the front, which may at first cause some confusion for non-French readers. Included in the volume are the physical properties of diamond and synthesis of diamonds. A major section is given over to kimberlite, including discussions of its character, geochemistry, mineralogy, and the genesis of diamond in kimberlite. Finally, the volume ends with chapters on various aspects of diamond exploration. Included is an insert describing Bardet's views of the major ideas related to diamonds, kimberlites, and mantle xenoliths discussed at the First Kimberlite Conference in Cape Town in 1973. The interested reader is better advised to consult the actual Proceedings volume (*Phys. Chem. Earth*, Vol. 9). Overall Volume 1 is a good but spotty review of diamond and kimberlite, and from the text it is obvious the author has particular ideas.

Volumes 2 (1976) and 3 (1977) cover the whole world in terms of diamond occurrences and, where pertinent, kimberlites. Volume 2 is devoted to the African continent, starting as is appropriate with southern Africa. Volume 3 covers the rest of the world, including the Americas, Russia, Asia, and Australia.

Unfortunately, the secretive nature of diamond exploration is evident in several sections and maps in these last two volumes, plus in certain instances the lack of accurate topographic maps of particular countries. For example, Guaniamo in Venezuela (Fig. 2, p. 79, Vol. III) is incorrectly sited, as are also some kimberlites in Mali (Fig. 11, p. 199, Vol. II).

Although scholars of the French language may take exception, I found Bardet to write with a very pedantic style, making English translation at times hazardous and problematic. At times it appears that M. Bardet has transcribed directly from his field reports to BRGM. Nevertheless, in spite of the numerous shortcomings these volumes are essential to anyone interested in diamonds and kimberlite, particularly in occurrences and exploration. Unless an English text is forthcoming, this work by Bardet will remain for many years as the "Bible" for "diamantists."

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STRUCTURAL CLAY PRODUCTS. Vol. 9 in Applied Mineralogy—Technische Mineralogie. By Wayne E. Brownell. Springer-Verlag, New York, 1976. ix + 231 pages. \$43.20.

Since the very beginnings of mineralogy there has been a close association of the science and its applications to problems of the mining, metallurgical, ceramic, and other industries. Recently in Europe special meetings devoted to topics in applied mineralogy and petrography have been held. In 1938 a journal devoted to those fields was founded as the *Zeitschrift für angewandte Mineralogie*, but it was short-lived because war broke out in Europe. After the war, interest in applied mineralogy and petrography was re-

vived. As a result of the increasing use of mineralogical and petrographical methods in applied research, the series of which this is Volume 9 was established by the house of Springer-Verlag. The subject of structural clay products is one that has not been monographed in recent years, so this treatise is a timely contribution. It was prepared for use in courses in ceramics, and it presupposes an adequate background in the basic sciences. The author makes an earnest effort to reach a wider audience of scientists and engineers who would find the volume useful. For this purpose he has included 320 references to the literature. In Chapter 1 Professor Brownell succinctly traces the history of structural clay products from brick-making in ancient and recent times.

The principal part of the treatise deals with exploration, mining, and processing of the raw materials. It then discusses, very thoroughly, the forming of the raw materials into finished ceramic wares by various processes. These include extrusion, drying, firing, and decoration. Chapters are also included on engineering problems, quality control, and the durability of the manufactured products.

Special stress is placed on the importance of the clay-water interaction in the process of forming the ceramic products. The mineralogical approach of DTA, TGA, and X-ray diffraction studies, taken chiefly from the literature, is used to interpret the reactions which take place in the firing of the raw materials.

The chapter entitled "Mineralogical Composition of Structural Clay Products" is so brief as to be of little use. Clay minerals, called disilicate minerals, are discussed in 13 pages of which 5 pages are taken up with illustrations! The accessory minerals, called non-essential minerals, are discussed in two pages which amounts to little more than a listing of the species. The three pages devoted to "Typical Mineral Compositions for Structural Clay Products" give useful data. Ceramic petrography is mentioned on page 13.

Mineralogists and geologists who teach ceramists can profit from reading this book by learning how their disciplines are applied. The book will be a valuable guide and source of information to scientists engaged in consulting work.

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TIME- AND STRATA-BOUND ORE DEPOSITS. Edited by D. D. Klemm and H. J. Schneider. Springer-Verlag, Berlin, 1977. 444 pages, 160 illustrations, 29 tables. \$43.00.

This volume is dedicated to Albert Maucher on his 70th birthday. It is a collection of interesting contributions (all in English, except for one by Paul Ramdohr on complex exsolutions from titanomagnetite) on a wide variety of topics. Although the theme of the book is presumably indicated by its title, the papers do diverge widely in direction and scientific content. Most are excellent, and I have by no means identified all of the valuable ones in the examples cited below. Twenty-eight well-referenced and well-illustrated articles are classed according to the following categories: (1) General topics: six papers, which include a stimulating discussion of the consequences of stratification of the oceans by E. T. Degens and P. Stoffers and a description of successful exploration in the Spanish-Portuguese pyrite belt by G. T. Strauss, J. Mandel, and F. F. Alonso. (2) Precambrian deposits: three papers, among which is a thoughtful synthesis of the origin of the huge Postmasburg and Kuruman (South Africa) manganese deposits by P. G. Söhnge. (3) Paleozoic deposits: eight papers, which include a

regional genetic synthesis of the Sb–W–Hg deposits of the Eastern Alps by R. Höll. (4) Mesozoic deposits: four papers, which include a comparison and paleogeographic reconstruction of important alpine Pb–Zn deposits by L. Brigo and six other authors. (5) Strata-bound intrusive deposits: two interpretative papers on chromite, one on the alpine type in Yugoslavia by S. Grafenaur and the other on the stratiform Bushveld Complex by R. Snelhage and G. von Gruenewaldt. (6) Geochemical and mineralogical problems: five papers, which include the diagenetic geochemistry of the Red Sea sulfide-bearing muds by K. Weber-Diefenbach.

The printing, paper, and illustrations are of high quality; typographical errors are numerous but are not a significant problem for the reader; the binding on my copy has begun to warp after a couple of months of traveling in my briefcase. *Time- and Strata-Bound Ore Deposits* is a useful reference and a good guide to further reading. Not everyone will need a shelf copy, but those interested in ore genesis or in prospecting for other than epithermal veins and porphyry Cu/Mo deposits can profit from this volume.

PAUL B. BARTON, JR.
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McGRAW-HILL ENCYCLOPEDIA OF THE GEOLOGICAL SCIENCES. David N. Lapidés, Editor in Chief. McGraw-Hill Book Company, New York, 1978. 915 pages, illustrated. \$29.50.

"This Encyclopedia provides a comprehensive treatment of the geological sciences, including geology, geochemistry, and geophysics, and of those aspects of oceanography and meteorology which are essential to understanding the materials, processes, composition, and physical characteristics of the solid part of the Earth system. The articles included in the Encyclopedia were selected by a Board of Consulting Editors and either have been taken from the *McGraw-Hill Encyclopedia of Science and Technology* (4th ed., 1977) or written especially for this volume. The broad scope of geological sciences is covered in great depth in the 560 alphabetically arranged articles on subjects such as plate tectonics, oceans, geological time scale, paleontology, mineralogy, physiographic provinces, orogeny, high-pressure phenomena, geophysical explorations, geochemistry and atmosphere chemistry. . . . An additional useful feature is a table in the Appendix which lists the properties of 1500 mineral species." (From the dust cover)

On the whole this encyclopedia achieves its stated purpose. It will serve as a useful reference work in libraries, and as an information source for those called on to provide quick answers to geological questions. Most of the contributors are recognized authorities in their fields of expertise. As pointed out in the above quotation, some articles have been taken from earlier works of this publishing house. Some were evidently written several years ago, as indicated by the references for further information; others have references to articles published as late as 1977. About 170 minerals are described, but there is considerable repetition; as well as a general article on feldspar, there are articles on albite, labradorite, orthoclase, etc. The sketches that accompany the mineral descriptions might well have been omitted, since they give no useful impression of the appearance of these minerals. The appendix "which lists the properties of 1500 mineral species" should have been better edited; it gives mineral name, chemical formula, crystal system, hardness, and specific gravity, but is not comprehensive, has numerous errors, and is not up-to-date. Lunar minerals such as armalcolite and tranquillityite are not included; discredited species such as flajolite (formula given as $\text{FeSbO}_4 \cdot 75\text{H}_2\text{O}$) are included; many varieties

of quartz such as chert, sard, jasper, prase are listed, without formula to indicate they are SiO_2 ; grossular [formula given as $\text{Ca}_3\text{Al}_2(\text{AlO}_4)_3$] is followed by grossularite, with the correct formula.

In spite of these deficiencies, however, this encyclopedia has considerable merits and will serve a useful function.

BRIAN MASON
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FORTSCHRITTE AUF DEM GEBIET DER KRISTALL-CHEMIE DER SILIKATE. By Friedrich Liebau. Rheinische-Westfälische Akademie der Wissenschaften, Vorträge Reihe N, Band 277; Opladen: Westdeutscher Verlag, 1978. 53 pages, 21 figures. 12 DM, approx. \$6.50.

This is a report of a presentation at a meeting in Düsseldorf, June 2, 1976. It is essentially an updated version of the author's chapter on the "Crystal chemistry of silicates" in the *Handbook of Geochemistry*, 1972, or it may be considered a preview of the author's long-awaited book on the subject. Principles are stressed throughout; no details of individual structures are given. The literature list includes only nine items from Machatschki's classic paper of 1928 and Bragg's first summary (1930) to the author's own review (1972). Emphasis is placed on the dependence of the spatial arrangement of silicate anions on the valence, size, and electro-negativity of the associated cations and on pressure and temperature.

The work is illustrated by many schematic drawings of silicate anions, drawn with admirable clarity to bring out those features discussed in the text. For instance, Figure 18 shows five types of Si_4O_{10} sheets, all pictured with the direction of view in the plane of the sheet. The text is followed by what seems to be a full report of a stimulating discussion with many participants, which is eminently worth reading.

ADOLF PABST
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MICROSCOPE PHOTOMETRY. By Horst Piller. Springer-Verlag, New York, 1977. 253 pages, 79 figures. \$30.00.

This book describes how the ordinary light microscope—supplemented by various mechanical, optical, and electrical modules—can be used to measure the intensity of light transmitted or reflected by microscopic particles. The techniques embrace the range of electromagnetic energy between wavelengths 250 and 1100nm, which is for convenience referred to as "light." This is timely, because the very sensitive photosensors now available will permit the techniques of optical crystallography to burst beyond the very narrow 400–700nm range to which they are presently confined. The author provides data of importance to microscopists contemplating expansion of their purview beyond the 400–700nm range.

The discussions are frequently technical and mathematical, and their major thrust, as the book's title implies, relates to the integration of a photosensor into the microscope system as well as the procedures (and pitfalls) in photometry with the microscope. Those contemplating photometric measurements through a microscope should read this book. Some of the figures and their arrangement, however, could be improved. Figure 2.1 a–n, which spreads across pages 5 to 8½, has a legend on pages 8 and 9 and is discussed

on pages 10–14. This provokes a good deal of page turning. Despite this, you'll want your library to order this book.

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THE MINERALOGY OF PENNSYLVANIA, 1966–1978. By Robert C. Smith II. Special Publication No. 1, Friends of Mineralogy, Pennsylvania Chapter, 1978. viii + 304 pages, 135 figures, 8 color plates (54 minerals). Available from Bryon Brookmyer, P.O. Box 19, Blue Ball, PA 17506. \$14.95 plus 60 cents postage.

This book is a supplement to *The Mineralogy of Pennsylvania* by S. G. Gordon, Spec. Publ. 1, Acad. Nat. Sci. Philadelphia (1922), and *The Mineralogy of Pennsylvania, 1922–1965*, by Arthur Montgomery, Spec. Publ. 9, Acad. Nat. Sci. Philadelphia (1969). It contains new data on 60 minerals, including much unpublished information, X-ray and optical measurements, and detailed data on many localities. A list of 276 verified minerals from Pennsylvania is given, and a brief history of Pennsylvania mineralogy (p. 10–17) by Martin L. Anné is included.

It is evident that Dr. Smith has worked with loving care to ensure the accuracy of the descriptions given. He has produced a volume that will be valuable to amateur collector and professional mineralogist alike.

MICHAEL FLEISCHER
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MINERAL CHEMISTRY OF METAL SULFIDES. By David J. Vaughan and James R. Craig. Cambridge Earth Science Series, Cambridge University Press, 1978, 493 pages, 167 figures, 47 tables. \$39.95.

Research on synthetic and natural metal sulfides in the past has involved metallurgists, mineralogists, chemists, and physicists, who employed a wide range of experimental and theoretical approaches. This book attempts to survey these methods and theories and to discuss the current state of knowledge regarding metal sulfides of mineralogical importance.

The book is written with the expressed hope that advanced undergraduate students, graduate students, and research workers will find it useful as an introduction to current work in this field. The text stresses discussions of the common sulfides but includes also, for purposes of comparison, comments on sulfides of rare occurrence and on arsenides, tellurides, and selenides. The sulfosalt minerals and compounds are specifically excluded.

The introductory chapter gives a very short outline of the history of sulfide research. The major portion of this chapter is used to provide the reader with a crystal-chemical background through discussions of atoms and ions; ionic, covalent and metallic bonds; crystal field theory; molecular orbital theory; and band theory. The next four chapters concern themselves with the arrangements of metal and sulfur atoms and the behavior of electrons in sulfide minerals. Thus, Chapter 2 treats crystal structures, Chapter 3 electrical and magnetic properties, Chapter 4 spectroscopic properties, and Chapter 5 deals with chemical bonding.

Chapter 6 on "Properties used in the classical determinative methods and their interpretation" deals with reflectivity and microscopic optical properties, hardness and microhardness, and with morphology and textures. Sulfide thermochemistry is treated

in Chapter 7 which, after defining and explaining some of the basic thermochemical concepts, discusses various methods of measurement of sulfur activity, thermochemical approximations, the phase rule, and diagrammatic presentations of observed phase relations.

Experimentally-determined sulfide phase equilibria are discussed in two chapters. Chapter 8 deals with "dry" equilibria. It describes synthesis and analytical techniques before treating one unary system (S), four binary systems (Fe–S, Zn–S, Cu–S and Ni–S), and three ternary systems (Cu–Zn–S, Cu–Fe–S, and Fe–Ni–S). In addition this chapter contains short reviews of experimental data on solid solutions among pyrite-type disulfides (CoS₂–NiS₂–FeS₂), thiospinels, and monosulfides (CaS–MgS–MnS–FeS). Chapter 9 deals with equilibria in "wet sulfide systems." It discusses diagrammatic representation of solution equilibria, and solubilities of metal sulfides.

The last chapter is devoted to studies of natural sulfides. It discusses the stabilities of sulfide minerals and their major-element variations, minor-element distributions, and sulfur isotopes, and lists a number of criteria that may be employed to estimate the conditions of formation of sulfides in ores.

The book contains three appendices of which the first (40 pages) lists compositions, mineral names, crystal structures, reflectivity, hardness, thermal stability, thermochemical, electrical, and magnetic data for sulfides. Appendix II (4 pages) lists reactions, free-energy changes, and temperature ranges for a considerable number of univariant sulfidation equilibria. Appendix III (21 pages) lists temperatures and reactions at invariant points in a large number of sulfide systems.

The book includes a 36-page list of references and a 17-page general index. In addition a short bibliography is given at the end of each chapter, and a list of references is included with each appendix.

This book is well written and organized. The authors are both known for their contributions to sulfide mineralogy, and the text leaves no doubt about their extensive knowledge of this field. Considerable effort has gone into reviewing the more recent developments (essentially through 1975) in sulfide mineral chemistry. This is welcomed by the reader because it is a rapid way to obtain valuable information without having to dig into hundreds of publications. The book contains an abundance of excellent tables and figures, most of which I found quite useful. Many of the discussions, particularly those pertaining to growth, twinning, exsolution, replacement, zoning, and breakdown textures are very short and would have benefited from good photomicrographs which are conspicuously lacking.

As a general rule the authors have attempted to list original references but quite often references are given to reviews (which commonly neglect to mention the original studies) or to other non-original papers.

The book has much to offer to graduate students and research workers in mineralogy, economic geology, metallurgy, chemistry, and solid-state physics, and should be found in libraries frequented by specialists in these fields.

The publisher deserves credit for a fine printing job. Printing errors are scarce. The binding is of high quality.

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GEOCHEMISTRY. By Arthur H. Brownlow. Prentice-Hall Incorporated, Englewood Cliffs, New Jersey, 1979. 528 pages. \$19.95.

Introductory geochemistry textbooks normally assume students may approach the subject with little or no background in chemistry and, indeed, little background in geology. This book is no exception. The early chapters deal with the elements (including electronic configuration, periodic behavior, abundance, and geochemical classification), isotopes (including radioactive dating), thermodynamics (including the phase rule and phase diagrams), and crystal chemistry. The material presented in these chapters is then applied, in five additional chapters, to studies of water chemistry, organic geochemistry, sedimentary rocks, igneous rocks, and metamorphic rocks. There are problem sets at the end of each chapter.

Such breadth of coverage would tax the capabilities of any author, and there are, perhaps inevitably, a number of conceptual errors in this first edition. The ones I caught include: an incorrect statement of LeChatelier's principle; consistent mislabeling of anhydrous phase diagrams with a $P_{\text{H}_2\text{O}} = 1$ atm tag and references in the text to the anhydrous laboratory work as low-pressure, water-saturated studies; and an incorrect discussion of fractional crystallization in the system forsterite–diopside–silica. However, these errors and others like them detract but little from the sound workmanlike job the author has done on most subjects. In the main the writing is lucid, but there are occasional lapses into murky obscurity, especially in the chapter on thermodynamics. There are also a couple of glaring errors in that chapter I mercifully refrain from discussing, since a case can be made that a geochemistry text is no place to learn thermodynamics anyway.

How does this book compare to Krauskopf's *Introduction to Geochemistry* (2nd edition, 1979)? They both cover virtually an identical range of subjects and are comparably priced. In general, Brownlow's book is more logically organized, uses figures more imaginatively, and makes much better use of recent field studies as illustrative examples in the chapters on sedimentary, igneous, and metamorphic rocks. Krauskopf's prose style is more concise and his book is 100 pages longer than Brownlow's, allowing better depth of coverage on many subjects. The second edition should be almost error-free. Brownlow partly offsets his brevity on certain topics by explicitly flagging the references wherein more extensive coverage may be found. In the end you "pays your money and takes your choice." Either book is an excellent value for the price.

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ELASTIC, PIEZOELECTRIC, PYROELECTRIC, PIEZOOPTIC, ELECTROOPTIC CONSTANTS, AND NON-LINEAR DIELECTRIC SUSCEPTIBILITIES OF CRYSTALS. By M. M. Choy and others. Vol. III/II (revised and extended edition of Vols. III/1 and III/2) of *Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology*, edited by K.-H. Hellwege and A. M. Hellwege. Springer-Verlag, Berlin, 1979. xvii + 854 pages, 677 figures. DM 780, approx. \$429.00.

This is a critical compilation of data published up to 1977 (the literature was searched to late 1977) on linear and non-linear elastic, pyroelectric, dielectric, and optical effects in crystals (and some other solid materials, including beef bone, coal, epoxy resin, mica schist, and red pine). The present volume fully maintains the high standard of this series. However, only a small amount of the data

is on minerals or compounds of mineralogical interest, and the price of the volume is a severe limitation on possible purchases.

BRIAN MASON
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ROCK-FORMING MINERALS, second edition; Volume 2A, Single-chain silicates. By W. A. Deer, R. A. Howie, and J. Zussmann. Wiley (Halsted Press), New York, 1978. 668 pages, 68 tables, 283 figures. \$55.00

As stated in the preface (dated July, 1977) to this edition, "The facility of rapid and accurate electron probe analysis has replaced to a great extent the more laborious chemical and optical analytical methods, giving many more reliable analyses for each mineral and enabling researchers to examine more specimens and to complete a wider range of studies in a shorter time. The availability of more well-analysed material has also lead [sic] to much more significant discussion of chemical variations and their relationships with crystal structure, physical properties and, most of all, parageneses. The important phenomena of fine-scale intergrowths (exsolution, etc.) and of chemical zoning have also been much more readily investigated using electron probe and other electron-optical methods.

"The study of phase equilibria at elevated pressures and temperatures has continued apace, so that the cumulative number of systems which need to be described has grown. In addition, much wider ranges of pressure and temperature have become accessible with improved techniques. At the same time, there has been a growth in the determination of thermodynamic properties of minerals, and in the experimental and theoretical approaches to element distribution within and between minerals.

"The advent and growing use of automatic single-crystal diffractometers has made it possible to determine crystal structures much more quickly, so that whereas there was hitherto perhaps one published structure for a mineral or even for a mineral group, now there can be structure determinations for a mineral at each of several chemical compositions, and at a number of different temperatures.

"The above, and other growth areas in mineralogy, have lead [sic] to the fact that in this edition the average number of pages devoted to each mineral is about three times that for the first edition. The extent of growth is indicated also by the list of references for each mineral which for this volume we have attempted to bring up to date to 1976, and the early months of 1977." (There are even references in footnotes to papers published in 1978.)

In the first edition the single-chain silicates were covered in 202 pages, 31 tables, and 52 figures. Not only have the number of tables been increased, but many of the original tables have been considerably expanded; for example, the number of orthopyroxene analyses (metamorphic rocks) has been increased from 18 to 35. Some minerals have been added: ureyite in the pyroxenes, and sapphirine, aenigmatite, rhönite, and serendibite to the non-pyroxene single-chain silicates. The number of systems referred to in the first edition was 37, in the second edition 145.

The authors are to be congratulated and thanked for their tremendous accomplishment in rendering an enormous mass of published information into a comprehensive and comprehensible form. I can only echo George Faust's comment on the first edition (*Am. Mineral.*, 50, 815, 1965), "For anyone engaged in the study of

rock-forming minerals or the origin and stability of rocks, (this volume is) absolutely necessary.”

BRIAN MASON
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URANIUM DEPOSITS, THEIR MINERALOGY AND ORIGIN. Edited by M. M. Kimberley. Mineralogical Association of Canada, Short Course Handbook Volume 3, University of Toronto Press, Toronto, Canada, 1978. 521 pages. \$12.00 Can, approx. \$10.25 US.

This 521-page volume was compiled for a uranium deposit short course sponsored by the Mineralogical Association of Canada and held immediately following the 1978 Annual Meeting in Toronto, Ontario, Canada, October 27–29. Material presented by 18 authors in 21 papers is organized in five sections—A through E. Section A which deals with Uranium Geochemistry consists of 3 chapters. The first of these, “Uranium Solution—Mineral Equilibria at Low Temperatures with Applications to Sedimentary Ore Deposits” by D. Langmuir, is an abbreviated version of a paper which appeared in *Geochim. Cosmochim. Acta*, 42 (6), 1978. The second, “The Mobility and Concentration of Uranium and its Decay Products in Temperate Surficial Environments,” is by W. Dyck, and the third, which is very short (3 pages) and which is authored by M. M. Kimberley, discusses “High-Temperature Uranium Geochemistry.” Section B treats Uranium Mineralogy in two chapters: “Uranium Minerals in Canada: Their Description, Identification and Field Guides” by H. R. Steacy and S. Kaiman, and “The Identification of Uraniferous Minerals” by R. D. Morton. Section C which is devoted to Classification and Description of Selected Deposits contains 5 chapters. These are “Genetic Aspects and Classification of Important Canadian Uranium Deposits” by R. H. McMillan, “Uranium Deposits in Australia” by F. F. Lanford, “Phanerozoic Uranium Deposits and Occurrences in Europe and Eastern North America” by V. Ruzicka, “Uranium Deposits in Ontario” by J. A. Robertson, and “Uranium Mineralization in Shallow Intrusive Environments” by J. E. Tilsley. Section D on Roll-Type and Stratiform Deposits contains another 5 chapters: “Uranium in Phanerozoic Sandstone and Volcanic Rocks” by R. H. DeVoto, “Uranium in Black Shales—A Review” by R. T. Bell, “Mineralogy and Setting of Elliott Lake Deposits” by N. J. Theis, “Origin of Stratiform Uranium Deposits in Sandstone, Conglomerate, and Pyroclastic Rock” by M. M. Kimberley, and “Mobility and Concentration of Uranium in Arid Surficial Environments” by F. F. Langford. Section E describes Deposits in Northern Saskatchewan. Its 6 chapters are on: “Classification of Uranium Deposits in Northern Saskatchewan” by J. Hoeve, “Application of Mineralogy to the Study of Multistage Uranium Mineralization in Remobilized Uranium Deposits, Saskatchewan” by J. Rimsaite, “Geologic Setting of the Beaverlodge-Type of Vein-Uranium Deposit and its Comparison to that of the Unconformity-Type” by L. P. Tremblay, “Mineralogy and Geological Settings of Unconformity-Type Uranium Deposits in Northern Saskatchewan” and “Uranium Concentrations Related to the Sub-Athabasca Unconformity, Northern Saskatchewan, Canada” both authored by J. Hoeve and T. I. I. Sibbald, and “Origin of Unconformity-Type Pitchblende Deposits in the Athabasca Basin of Saskatchewan” by F. F. Langford.

The last 18 pages of this volume contain a rather useful glossary of mineral names, abbreviations, and geologic terms as used in the text. The reader will miss a general subject index.

As pointed out by the editor, this volume does not represent a comprehensive, evenly-balanced treatment of worldwide uranium deposits or mineralogy. About one half of the text is devoted to Canadian deposits. It was compiled in the hope that it would prove useful in the teaching of both undergraduate and graduate courses on mineral deposits and that it also would be of value to the uranium exploration industry. In this reviewer's opinion this book will be much appreciated by teachers and students as well as exploration geologists.

Most chapters are well illustrated, although some of the photomicrographs are poorly reproduced, and the authors have almost without exception provided adequate lists of references at the end of each chapter. It is very difficult to achieve uniform quality throughout a volume composed of chapters by so many authors. Some of the authors present their material with a great deal of thought and care; others appear to have been in a hurry. Some chapters represent in-depth studies; others are rather superficial. Some chapters are long (in excess of 40 pages), and others are rather short (3–6 pages).

In all the book represents a valuable addition to the literature on uranium deposits. The very reasonable price of Canadian \$12.00 makes the book a real buy. It should find extensive use.

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ATLAS DES MINERAUX METALLIQUES. By P. Picot and Z. Johan. Bureau de Recherches Géologiques et Minières No. 90, Orléans, 1977. 406 pages. 320 fr, approx. \$64.00.

Here, in a rare blend of beauty and science, is a book which is both an informative mineralogical reference and a bona fide work of art. It is primarily a photographic compendium of the varied colors and textures of ore and common gangue minerals alphabetically arranged, from aguilarite to zircon, for about 350 species. As such it contains some 320 photomicrographs. Fifty-five photos are specifically of textures and 265 are of individual minerals; 219 of this latter group are in color. The book is divided into two sections, one dealing with metallographic techniques and the other devoted to specific mineral descriptions. The first part includes: a brief synopsis of metallogenic study; a short description of polished section preparation; a summary of the nature of diagnostic characteristics; a listing of the principal types of metallogenic paragenesis and their common mineral constituents; a listing of minerals according to reflectivities; listings of minerals by color (in air and under crossed nicols), by internal reflections, by twinning, by exsolution features; a listing of sulfosalts and their distinctive characteristics; a pictorial review of diverse structures; and a description of the photographic equipment used in the preparation of this book. The second part of the book is an alphabetical listing of the minerals of metallogenic deposits and includes for each: a color photomicrograph (omitted or black and white for only a few); the perceived color; Mohs hardness; relative reflectivity; anisotropism; structures (twinning, zoning, tendency toward growth of euhedral crystals); associated minerals; representative ore deposits; diagnostic characteristics; and a table of reflectivity values at 20 nm intervals from 420 to 700 nm.

The samples included in this atlas were all selected from the reference collections of the Bureau de Recherches Géologiques et Minières and were obviously chosen on the basis of esthetics as much or more than upon the typical mode of occurrence. There

does appear to be a bit of a preoccupation with rare minerals (where else could one find a color photograph of bukovite, $\text{Cu}_3\text{TiFeSe}_4$, eucairite, AgCuSe , lorandite, TlAsS_2 , or paxite, CuAs_2 , at the expense of more common ones) (there are no photographs accompanying the descriptions of pyrite, galena, chalcopyrite, and tetrahedrite). Nevertheless the text layout is well done, and the photomicrographs are excellent. The textures shown in the photographs are illustrative of the diversity and beauty in the realm of metallogenic minerals. The book is a must for all of those interested in ore microscopy, and should be shown to all students if for no other reason than developing their appreciation of ore microscopy.

The text is totally in French but is straight-forward, well written, and easily understood.

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NATURAL ZEOLITES: OCCURRENCES, PROPERTIES, USE. Edited by L. B. Sand and F. A. Mumpton. Pergamon Press, Inc., New York, 1978. xi + 546 pages. \$75.00.

This book is made up of "a selection of papers" from those presented at "Zeolite 76," an international conference held in Tucson, Arizona in June, 1976 on the occurrence, properties and utilization of natural zeolites.

The papers are grouped, after an introduction by F. A. Mumpton, under the following section headings: I. Crystal Structure and Mineralogy, II. Geology and Occurrences, III. Physical and Chemical Properties, and IV. Applications. The introduction is informative and has ample references. It begins with a historical review, summarizes the parageneses of zeolites, and ends with a brief summary of the applications of zeolites. It provides non-zeolite persons with an appreciation of the rapidly growing importance of zeolites.

In section I (8 papers), Glauco Gottardi gives a brief overview of zeolite crystal chemistry and structures. The state of the art in structure refinements of several species is discussed. Stereoscopic pairs to illustrate two or three zeolite structures would have enhanced this paper, whereas the six very poor photomicrographs of "pseudomeroedric" twinning add nothing (except an unfamiliar term). Three of the remaining papers in this section are very specialized. In one 23-page paper 12 pages are besmeared with nothing but structure factors; another five pages in the same paper are covered with atomic positions and interatomic angles *etc.* of hydrated and dehydrated potassium-exchanged ptilolite. The section is redeemed by three short and interestingly written papers. The first is by J. M. Bennett and R. W. Grose who, by a variety of analytical techniques, reveal the true (we hope) identity of a previously misinterpreted intergrowth of zeolites from Oregon. The second is by W. M. Meier who, concisely and with clear illustrations, describes the main features of the various constituent sheets making up the frameworks of zeolites related to mordenite. The third is Mumpton's and Ormsby's paper on the morphology of zeolites as studied by scanning electron microscopy (SEM). This is one of the more important tools for identifying zeolite crystallites; fortunately the quality of the prints is better than that of most of the others in the book. A paper by William S. Wise and R. W. Tschernich is also worthy of mention. It discusses the sequential formation of a low-temperature series of (mostly) zeolites with

special reference to the activity of silica and the rare zeolite dachardite, in Washington and Oregon.

By far the largest section of the book is that devoted to Geology and Occurrences (17 papers). After a general paper by R. L. Hay on parageneses there is a series of 13 papers on the most common zeolites from the most widespread environments and paleoenvironments (*e.g.*, of saline and alkaline lakes, of marine deposits, old and young, and of geothermal regions). Two papers, one by A. Iijima and the other by M. Kastner and Sharon A. Stonecipher, with ample references provide comprehensive coverage, with no objectionable overlapping, of marine zeolites. Four papers are on clinoptilolite and/or phillipsite, the two most abundant first-formed marine zeolites. There are four papers on the zeolites of specific regions: Iceland, Italy, Auckland (New Zealand), and Bowie (Arizona), and two papers on hydrothermal experimental work. The quality and style of these papers cover a wide range. In one of the papers on hydrothermal experimentation, for example, the pressure is described as "autogenous," the fluid composition as "natural composition," and the container (of the heated NaOH solution) as "Pyrex." Most of the papers are of much higher caliber and the section as a whole provides a quality core for the book. Unfortunately some papers suffer from the deplorable quality of certain photographic prints.

The third section (8 papers) is devoted to zeolites' physical and chemical properties insofar as these are important in applications. Thus there is a great emphasis on cation exchange, adsorption, and catalysis. D. E. W. Vaughan gives the introductory paper with many well-chosen references. Y. H. Ma and Ting Yueh give a useful tabulation of previous sorption studies done on various natural zeolites, mostly chabazites. R. M. Barrer, who has worked in the laboratory on zeolites for longer than anyone, has an excellent review paper on cation exchange properties. Understandably, 28 out of the 36 references are to his own previous work. Thermal stability is the subject of one paper (on gmelinite).

The last section (11 papers) on Applications starts with a broad view of zeolite uses in Japan. Since most general types of applications for zeolites elsewhere are found also in Japan, the paper serves as a good introduction to this section. Other papers describe more specific examples of waste-water treatment (including the removal of ammonia and radioactive elements, and the recovery of heavy metals), of adsorption (in solar collectors for space heating and cooling, and in the collection of ammonia resulting from coal gasification), and of catalysis (in the recovery of sulfur from H_2S).

In summary, the book is well organized and, considering its large size (546 8" \times 11 1/2" pages), remarkably free of misprints. Since so many references are repeatedly cited by different authors, it would have been desirable to have had a single list of references at the end of each section. The quality of the printing (*i.e.* of the photographs) unfortunately does not match the quality of the editing. In spite of its high price the book will doubtless be a must for all those who attended the conference (or would have liked to do so but could not). In addition, it must at present be regarded as the most up-to-date and comprehensive collection of data on natural stratabound zeolites in any single volume.

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GENESE DES KAOLINS. Edited by Manfred Störr. (Volume 11 of the *Schriftenreihe für Geologische Wissenschaften*). Akademie-Verlag, Berlin, German Democratic Republic. 350 pages, 164 figures, 58 tables. 68 M, approx. \$40.00.

This nicely produced volume, with a reasonably good paper cover, contains 26 of the papers presented at the Fifth International Symposium on the Genesis of Kaolin, held in Dresden, GDR, 14–20 September 1975, with 18 papers in German, 7 in English, and 1 in French. Comprehensive summaries are provided in Russian, German, and English. Most of the papers come from eastern European countries and the USSR, with a sprinkling from other countries including two from the USA, by W. D. Keller and H. H. Murray *et al.* As the title indicates, all the papers are concerned with a common theme, how kaolin is formed, but the variety of geologic environments and processes involved is such that it is indeed worthwhile to have this compilation of detailed information from many sources. Methods of investigation are broadly the same, detailed geologic mapping, chemical analyses and X-ray identification of phases, but other techniques, notably use of scanning electron micrographs, also are utilized. Keller provides a broad survey of the textures and crystal morphology of kaolins formed under different conditions, and Lange applies the method to a study of the role of porosity in weathering processes. SEM pictures also appear in other papers. Petrov *et al.* show the epitaxial development of kaolinite on K-feldspar and of halloysite on acid plagioclase by vacuum vaporization of gold on the developing phases, the gold being taken up preferentially on crystal edges. Nikitina, Berchin and Zvyagin discuss kaolinite and halloysite formation in the bauxite formations of the Ukrainian Shield and give more attention to crystalline order–disorder than appears in most of the papers. They find significant variations in crystalline order in both kaolinites and halloysites; in rare cases they observed the two-layer monoclinic halloysite structure which Zvyagin has previously discussed. Chukhrov's broadly ranging paper on the variety of eluvial clays also shows striking electron-optical pictures of polygonal or prismatic halloysites. Rus'ko also discusses the age and genesis of kaolins in the Ukrainian Shield and uses gold decoration to show the initial crystallization of kaolinite on cleaved mica surfaces. An outstanding paper is provided by Störr of the GDR and Kuzvart and Neuzil of Czechoslovakia on the principal periods of kaolin formation on the Bohemian Massif ranging from the Ordovician to the Upper Mesozoic, illustrated by maps, charts, and cross-sections. A contribution by

Landgraf, which differs from most of those in this monograph, places emphasis on a mixed-layer mica–montmorillonite present in the kaolins of the Kemmlitz region which has an important bearing on their technological properties. He describes a procedure for determining the proportion of expandable layers of absorbing a high-refractive-index liquid (tetraphenyl phosphonium bromide) and measuring the resultant refractive index. Mineral synthesis studies do not figure prominently in this volume, probably because low-temperature synthesis of kaolinite has been a very intractable subject. However, Harder provides a general review of low-temperature syntheses of clay minerals; he discusses the possible role of organic acids, such as humic acid, in the formation of kaolinite, citing the work of Linares and Huertas, which has been continued more recently with promising results by La Iglesia and Martin Vivaldi. These later developments, however, came too late for incorporation in this volume.

The attention of readers interested in the book under review may be directed to another publication, also edited by Manfred Störr, and also related to the same kaolin symposium, namely *Kaolin Deposits of the GDR in the Northern Region of the Bohemian Massif*. This volume, reviewed by W. D. Keller, in *Clays and Clay Minerals*, 24, p. 105, 1976, was prepared to provide "a basis for discussion for the kaolin symposium to be held in Dresden, September 1975." Keller describes this book, which is in "good, readable English," as excellent and "a top-notch treatment of what a symposium and field guide can be." My impression is that the two books complement each other. The present book clearly has a much broader area of interest.

The present symposium, together with those which have gone before it and several which have followed it, provide an immense collection of data which must now be integrated. It is my understanding that the Committee on Correlation of Age and Genesis of Kaolin, under its secretary, Dr. Milos Kuzvart of Prague, is planning at least one monograph documenting the results of these meetings and field excursions. Whether other aspects of the investigation of kaolin, such as mining and technological aspects, will also be treated is under discussion.

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