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BOOK REVIEWS

CLAYS AND THE RESOURCE GEOLOGIST, Edited by F. J. Longstaff. Available from Mineralogical Association of Canada, c/o Dept. of Mineralogy and Geology, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario M5S 2C6. $12.00 Canadian.

One should not gather from the title of this rather brief paperback volume that it is a comprehensive survey of clay and economic and petroleum geology. Some chapters are of the nature of reviews, while others focus more narrowly on clays in reservoir sandstones. One can look at the handbook as dealing with four areas: (1) clay mineral structures and identification, (2) identification of mixed layer assemblages and their relation to shale diagenesis, (3) diagenesis in reservoir sandstones, (4) equilibrium thermodynamics and the estimation of diagenetic conditions. Chapters 1 and 2 by G. W. Brindley contain a lucid review of the structures of the clay minerals, and of the methods used to identify these minerals by X-ray diffraction, including an interesting discussion on the principal problems encountered in routine identification work. These two chapters are designed as a foundation for the chapters which follow, not as a comprehensive review.

Chapter 3 by John Hower presents the details of diffractograms of interlayered illite/smectite, and chlorite/smectite with varying mineral ratios and with varying degrees of regularity of repetition. The application of this type of analysis is discussed in Chapter 4, also by Hower, as applied to the problems of shale burial diagenesis. This discussion relies on a specific case approach, particularly as shown by samples from the Gulf Coast and points up the numerous interpretative problems that the analyst may encounter.

One encounters a fault in crossing to chapter 5 in that the scientific and academic emphasis in chapter 1–4 is juxtaposed against the practical concerns of the effects of clays on the flow and fluids into a well bore. The authors (W. R. Almon, D. K. Davies) ask and answer questions regarding improvement treatments and their effects on the clay-pore system in sands, and how one determines what will be a compatible improvement treatment.

J. B. Thomas, in a short chapter with a long title, generalizes about clay structures, outlines some drilling and production case histories but does not draw conclusions. He also presents some generalizations regarding clay occurrences and environments of deposition. This chapter did not integrate observations and will not be very helpful to mineralogists.

In chapter 7, W. R. Almon presents a petrologic description and study of the Rotliegendes sand of the North Sea and indicates the diagenetic changes (illite, kaolinite, quartz growth) that reduce formation quality. The causes of the changes are related to solutions produced from the Zechstein evaporites. This case history is an interesting example of formation damage due to diagenetic growth.

In chapter 8, J. R. Boles details another case study showing the effects of illitization of smectite, with the consequent release of silica, iron, magnesium, and the reaction of these constitutents to produce sandstone cements in the Wilcox and Frio sandstones. This is an interesting chapter which ties in with the earlier presentation by Hower.

Chapter 9 strikes off in a theoretical direction, as I. Hutcheon asks if equilibrium thermodynamics involving pore water and authigenic phases can predict the changes in these phases with changes in burial temperatures and pressures. After a discussion of basic equilibrium thermodynamics, systems containing kaolinite, illite, and alkali feldspars are related to pore water compositional changes with changes in burial temperatures and pressures. Further considerations involve systems showing equilibria betweeen dolomite, kaolinite, chlorite, and calcite and which release carbon dioxide during burial diagenesis. Finally, the effects of man-induced changes as a result of steam injections into tar sands are considered (smectite production from albite/analcime).

The value of this handbook to those outside the short course derives from its presentation of some interesting examples of diagenetic changes involving clay minerals. It could be useful to those directly involved with clay-mineral-porosity problems in reservoir rocks, and to those teaching courses involving clay mineralogy.

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MINERALOGY FOR STUDENTS, second edition. By M. H. Battey. Longman, Inc., New York, 1981. xii + 355 pages. paperback $19.95.

American mineralogists take pride in the heritage of James Dwight Dana's system of mineralogy which was so comprehensive and progressive that it set the course of mineralogy in this country for the last one and a half centuries. His first book was published in 1837, was subsequently improved and updated, and then converted into textbooks coauthored by other outstanding mineralogists. Dana's system started with the philosophy of the early natural historians when minerals were classified and described just like botanical and zoological species. As mineralogists recognized that the evolutionary ties of biological species do not apply to minerals and as the basic sciences developed, Dana's system adjusted to the changing philosophy and retained its contemporary values.

Textbooks based on Dana's system are still the most popular books in mineralogy classes in the U.S. and in Canada, although lately more and more concerns have been expressed about the traditional teaching of mineralogy and the need to bring mineralogy in line with current advances in the basic physical sciences. Most progressive geology departments have already introduced new mineralogy curricula in which mineralogy is more the chemistry and physics of natural inorganic solids than a descriptive art which treats the basic sciences as appendices.

Any new textbook of mineralogy, introduced in the late 20th century, faces the difficult task of either offering substantial improvements over the current textbooks based on Dana's system, or introducing a progressive and much needed physical–chemical approach to mineralogy.

Battey's "Mineralogy for Students" is refreshingly different from other mineralogy texts. Even the chapter headings differ from the customary titles. Part I of the book is devoted to "Principles and Methods" and discusses the following topics in 6

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chapters: crystal structures; crystal descriptions; physical properties; optical properties; X-ray diffraction; and mineral associations. Part II is on descriptive mineralogy. In addition to the conventional description of the properties of minerals a large number of crystal structure diagrams are offered and the optical properties of minerals are treated in more detail than in most other mineralogy texts. The appendices at the end of the book give even more information on descriptive physical properties, including diagrams illustrating the optic orientations of the important minerals. The strength of the book is clearly concentrated in the descriptive part, although its usefulness in the identification of minerals is tarnished by the absence of a mineral identification table.

The weakness of the book is in Part I, in the discussion of the mineralogical concepts. Chapter 1 is entitled "The Principle of Crystal Structure", but in fact, is limited to a review of bonding types and Pauling's rules, and to some comments on isomorphism and polymorphism. In spite of the brevity of these discussions, some basic concepts of crystal chemistry are brought up in the discussion of the individual structures of minerals, in Part II. Crystallography is similarly short handed. It is limited to a brief and old-fashioned discussion of lattices and to a half a page on the symmetries of crystal classes. The rest of chapter 2 is devoted, almost fully, to crystal measurements, drawings, axial ratios and similar topics. The lack of adequate discussion of symmetry leaves serious gaps in the development of crystallographic concepts and frequently leads to erroneous impressions. Enantiomorphism, for example, is discussed as an exclusive feature of crystal forms and is equated with right—and left-handed, and with positive and negative forms. The concluding statement of this discussion leaves the student with the impression that inversion and reflection are not enantiomorphous symmetry operations. The coverage of chemistry is largely limited to chemical compositions and their variations, and physical mineralogy is exhausted by the review of the identification-related physical properties of minerals. More recent developments in mineralogy are either ignored or are skimmed over. The term "polytypism", for example, is not included in the book's vocabulary, although the concept is touched on as a form of polymorphism, in the description of the micas. There appears to be a distinct conceptual dichotomy throughout this book in the discussion of concepts and in the description of minerals.

All considered, the author achieved his goal and should be commended. He introduced the fundamental mineralogical concepts and with the emphasis on descriptive mineralogy he produced a practical text "for students".

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PHOTOELASTIC AND ELECTRO-OPTIC PROPERTIES OF CRYSTALS. By T. S. Narasimhamurty. Plenum Press, New York, 1981. 514 pages. $37.50

Never before has there been an attempt to bring together under one cover such a thorough treatment of the subjects of photoelastic and electro-optic properties of crystals. The author has gathered material scattered throughout a diverse literature for the past 160 years since David Brewster first observed photoelastic birefringence in stressed glasses and crystals and culminating in the virtual explosion of activity and information with the advent of the laser in recent years.

Photoelastic and electro-optic properties are simply those optical properties that result when a stress or an electric field is applied to a substance. Photoelastic properties have been of great value to engineers in studying the effects of stress on structures. In more recent years, however, photoelastic properties have taken on new significance with such applications as Brillouin scattering as a means of measuring elastic moduli of very small crystals and crystals under pressure. Brillouin scattering and other related techniques are finding increasing application in crystal chemistry, mineralogy, and geophysics.

Narasimhamurty's book is very technical as it must be in order to cover the material as thoroughtly as it does. However, it is surprisingly readable. The author gives very interesting historical background, he defines his terms carefully, and he introduces the mathematical tools (mostly tensors) with a very logical development and well-known examples. In a similar manner, he also reviews the necessary crystallographic concepts and notations. The organization is beautiful and serves the reader who uses the book for reference just as well as it serves the person who reads the book from beginning to end.

There are many subjects covered in this book which may be of interest to earth scientists, the effect of stress on refractive index, the diffraction of light as it interacts with acoustic waves, the doppler shift of light scattered off of phonons (Brillouin scattering), the effect of electrical fields on optical properties, the control of light by electric impulses (Pockels cell and Kerr cell), and the potential that these have for studying the properties of materials. Perhaps the greatest value of this book is the confidence it affords the scientist just embarking on research employing any of these phenomena by providing him with a ready reference that is so thorough and so well organized that he has an excellent chance of finding answers to any questions that arise in the course of his research.

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THE SPINDLE STAGE: PRINCIPLES AND PRACTICE. By F. Donald Bloss. Cambridge University Press, New York, 1981. xii + 338 pages. $69.95.

The technique of attaching a mineral grain to the end of a needle and preparing a mount so that all indices of refraction can be measured directly on the stage of the polarizing microscope was first described by Rosenfeld in 1950. Wilcox (1959) made substantial improvements in the device, termed it a "spindle stage", and outlined procedures for maximizing its effectiveness. Bloss and his co-workers at V.P.I. have likewise made further improvements, introducing the so-called detent spindel stage. They have, as well, prepared elaborate computer programs for analyzing optical data obtained by the spindle stage.

Most of the information needed for successful manipulation of the spindle stage, and for the measurement of the optical properties of minerals is covered in the first 3 of the 9 chapters in this book. These chapters are meticulously written and profusely illustrated with original line drawings. The stereographic net is a crucial adjunct to correct manipulation of the spindle stage and methods for plotting equational and polar extinction curves, crossover points, wave fronts, optic axes, *etc.* are given in such elaborate detail that they should be understandable to any student who has had some training in polarizing microscopy. Methods of determining 2V accurately, both orthoscopically and conoscopically are given considerable attention, ranging from the familiar Mallard method to much less well-known methods of

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computation based upon angles measureable from stereographic plots of the so-called extinction curves.

Chapter 4 is a rather short but concise, and up-to-date summary of index variation (or dispersion) methods. This is followed (Chapter 5) by a discussion of the accuracy, precision, and techniques of index measurement. In these two chapters, Bloss points out that, with proper care, indices should be measureable at any visible wavelength to an accuracy of 0.0002, or an order of magnitude better than we achieve in routine optical work.

Chapter 6 begins with an interesting discussion of optical devices for measuring extinctions accurately. Most of these are known only vaguely by most petrologists and mineralogists, so this part of the chapter can be read with profit. The remainder of Chapter 6 however, will be totally lost on most readers because it goes into lengthy detail on how to execute and prepare cards for program EXCALIBR which refines the optical data. A footnote informs us we may obtain the program in 9-track tape from V.P.I., but for the defenseless first-reader of "The Spindle Stage", this is really not very helpful.

Optical measurements made on a spindle stage that accommodates an X-ray goniometer head can be used very advantageously to improve the efficiency of X-ray analyses, and this is the subject of Chapter 7. The specific procedures to be followed are not immediately obvious, but as with the first three chapters, there is a profusion of illustrative material, and careful explanation.

A method for determining retardation to an accuracy of 0.0001, relying upon the spindle stage in part, is outlined in Chapter 8. Unfortunately, the V.P.I. program RETARD is integrated into the discussion and this, in turn, depends upon output from EXCALIBR. It would have been more useful to the general reader to have the mathematics developed independently, and then to point out their compatibility with computational techniques.

Chapter 9 is a very brief summary of some of Bloss' research on cordierite and plagioclase, demonstrating both the usefulness of spindle stage techniques, and also how well they supplement heating-stage experiments.

For those who teach advanced techniques of the polarizing microscope *The Spindle Stage: Principles and Practice* is the essential (and the only) reference available. Johannsen's (1918) *Manual of Petrographic Methods* is the closest analogue, but is badly outdated, lacking for example, any reference to such improvements as the spindle stage. If, at some future date, Bloss' *Spindle Stage* reaches the point of a second edition, a new book entitled *Advanced Techniques of Optical Microscopy* which would include much of the material in this book, plus a summary of universal stage, minimum deviation, and other techniques would be godsend for all mineralogists and petrologists.

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NOTICES

AGI Minority Participation Program Scholarships

The American Geological Institute will again offer scholarships for geoscience majors who are United States citizens and members of the following ethnic minority groups: Blacks, Hispanics, and Native Americans (American Indian, Eskimo, Hawaiian, Samoan, or other qualified Native minority). Approximately 70 such awards (ranging from $500 to $1500 were granted in 1982–1983. About the same number (and amounts) will be awarded for 1983–1984.

The term "geoscience" is used broadly to include major study in the fields of geology, geochemistry, geophysics, hydrology, meteorology, oceanography, and space and planetary sciences.

Monies for support/funding of this program are administered by the AGI Minority Participation Program Advisory Committee and have come from six member societies, more than 16 mining, petroleum, geological supply, and geophysical companies, and many individuals.

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