Geophysics

Paul Melchior's comprehensive book **The Earth Tides** (Pergamon, New York, 1966. 472 pp., illus. $17.50) is the first to summarize coherently the voluminous theoretical and experimental contributions to the subject scattered throughout various scientific publications of more than half a century.

The book begins with a brief introduction followed by three major parts, with an appendix on moon tides. Part 1 is devoted to the development of static tide theory. Several useful methods of harmonic analysis and data processing are discussed. A lengthy description of the use of an IBM 1620 is also given. Unfortunately, these methods, including the Lecolazet method which Melchior favors, do not fully utilize the data of a long series, and, as they stand, are generally limited to the analysis of a 30-day series, which is insufficient to permit separation of some principal tidal constituents. Other techniques—least squares, power spectra, filtering, correlations, and so on—for analyzing arbitrary lengths of geophysical time-series data are omitted.

Part 2 summarizes experimental results, including those obtained during the International Geophysical Year, of deflection of the vertical, of variations in the intensity of gravity, of changes of linear strain, and of cubic expansion of the crust. Measurements of the horizontal pendulums, particularly of the Verbaandert-Melchior type, are quite detailed; appropriate anecdotes as well as personal experiences are interspersed. A thoughtful discussion is found in the chapter "Earth tides in relation to physical, geophysical, and geological problems."

Part 3 deals with the fundamental theory of solid earth tides. Molodensky's theory on the dynamic effects of a liquid core on earth tides is presented in what Melchior refers to as "logical deduction rather than detailed mathematical development." Jeffreys and Vicente's theory on the same subject is only very briefly mentioned. The continuity of Part 3 is somewhat disturbed by the inclusion of the chapter "Rheology of the earth" in the midst of earth-tide theory and dynamic effects of a liquid core.

A very useful and complete bibliography from 1800 to 1959 and the supplements from 1959 to 1964 are included at the end of the book. In addition to author and subject indexes for the entire volume, there is also an index to the bibliography. For a first edition, typographical errors are at a minimum.

Despite a few shortcomings, the book as a whole undoubtedly fills the need for an organized summary of the classic field of earth tides. Advanced students and research workers in geophysics will find it a valuable reference.

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Objects and Images

It is unusual to find a book on the microscope in which little or nothing is said about the microscope itself. There are many other books dealing with microscopes and with their use in various technical fields, however, and instead of duplicating these treatments, L. C. Martin, the author of **The Theory of the Microscope** (Elsevier, New York, 1966. 502 pp., illus. $19.50) has undertaken to explain in a very simple and clear fashion how the microscope forms an image, and the relation between the object on the stage and the image that you see in the eyepiece. Abbe, over 90 years ago, recognized that there is a fundamental distinction between the imagery of self-luminous and illuminated objects, and he developed an elementary theory of coherent illumination to explain this. Succeeding workers have greatly elaborated the theory, extending it to include different types of opaque and phase objects. The mathematics here can become formidable unless some simplifying assumptions are made.

The present book contains some perfect examples of a physical model rendered precise by mathematical reasoning. The author does not hesitate to use integrals and Bessel functions where necessary, but he remembers that they are merely tools and that the average reader will learn far more from the extensive explanations than from the mathematics.

For structures at the limit of resolution of the microscope, it is evident that the convenient ray fictions of geometrical optics are no longer applicable. Instead, we are deep in a problem of wave optics. Martin's treatment deals almost entirely with waves, phases, interference, diffraction, and coherence, yet in his hands, with the assistance of numerous unusually clear diagrams, these rather abstruse aspects of microscope imagery become wonderfully clear.

The first three chapters of the book constitute a compact and admirable survey of the basic knowledge of optics which is required for a proper understanding of the microscope. Indeed, they should be required reading for anyone who plans to design or use any image-forming optical system. Chapter 1 covers the fundamental first-order (Gaussian) theory of lenses and mirrors, and photometry. The second chapter moves into the field of vibrations and waves, with Huygens' principle, Young's interference experiment, Fresnel and Fraunhofer diffraction, and the Airy disc. In the third chapter, simple instruments are considered: the microscope and magnifier, eyepieces, entrance and exit pupils, condensers, and image illumination. Chromatic and spherical aberrations are considered in both ray and wave notation. The construction of refracting and reflecting microscope objectives is discussed briefly.

Chapters 4 to 6, representing about one-third of the book, deal with the very important matter of coherent and incoherent illumination in image-forming systems. The incoherent case (a self-luminous object) is generally familiar, and the light distribution in the image of a point, disc, line, grating, and edge have been known for many years. A brief and useful summary of the principal results in this field is given in chapter 4. The subject of partial coherence is introduced in chapter 5, and many of the important phenomena are very simply and clearly treated. In chapter 6 the effects of coherent illumination when objects are viewed under the microscope are covered in detail, including the Abbe theory, grating images, Köhler illumination, dark-ground effects, and the convolution theorem.

Chapter 7 deals with the microscopy of phase objects, presents many excellent explanatory diagrams and worked examples, and concludes with a discussion of phase-contrast microscopy and the many types of interference microscope. In chapter 8 some examples of typical microscopical objects under illumination with various degrees of partial coherence are considered. Appendixes cover the mathematics of Fourier series and integrals, the image

of a sine grating, and Kirchhoff's diffraction integral.

This book can be very strongly recommended to any worker who has the curiosity to wonder about the how and why of image formation at the diffraction limit, as it occurs in a high-power microscope. The effort to follow the author's very clear explanations will be well rewarded. The numerous diagrams are unusually good, and the whole publication is an excellent achievement.

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Armchair Field Experience

Geology Illustrated, by John S. Shelton (Freeman, San Francisco, 1966. 446 pp., illus. $10), presents 382 figures, mainly excellent aerial and ground photographs taken by the author or clever pictorial sketches and diagrams drawn by his brother, Hal Shelton. But the real value lies in its text, which is thoughtfully organized, clearly presented, and replete with modern ideas.

The outline includes six principal headings: materials, structures, sculpture, time, case histories, and implications. Thirty-seven secondary headings are subdivided into 150 parts, each of which is a short essay that typically raises questions, identifies evidence, and considers arguments that might be useful in explaining features displayed in a photograph on the same or an adjacent page. Skillful mastery of English and absence of jargon characterize the text. A few definitions are stated conventionally, but most technical terms are explained. Starting with simple observations and concepts, the text advances methodically into more complex problems. An interested layman or a student fortunate enough to use the book as a text will acquire the essential vocabulary of geology, intimate familiarity with the field, and background for discriminating between fact and speculation.

Now that earth scientists are inclined to keep their boots unmuddied and turn to speculation and analysis as a panacea, it is refreshing to find a text emphasizing the necessity for field observations. Using the case method, Shelton presents a landscape photographically and raises questions concerning its origin. He pinpoints essential features, suggests possible explanations, indicates associated evidence, and, without dogmatism, furnishes guides for arrival at rational explanations. In many cases successive photographs are used to focus attention on critical evidence. Some of these are closer views from the air, most are closeups taken on the ground, but where need arises microscopic details exhibited in rock thin-sections (ordinarily with 10-power magnification) are used, mainly to explain rock structures and textures. The result is probably the most successful substitute for field experience ever presented in a book, and also one that demonstrates the necessity of and whets a desire for field work.

Emphasis is placed on the American West for valid reasons: other parts of North America lack the variety and interest of the area where so many of our geologic concepts originated, and also it is the region most familiar to the author. High relief and relative absence of soil and vegetational cover render western landscapes particularly photogenic. But other parts of the continent are not unduly neglected, and some discussions involve other parts of the world. The acknowledgments constitute a list of most living leaders in geological research, but throughout the text one may identify above all the influence of Alfred O. Woodford, who for some 30 years was closely associated with the author.

The publisher deserves congratulations for accepting an outstanding manuscript, for skill in book manufacturing, and for keeping the price within the range of students. The treatment is so up-to-date and original that an instructor adopting the text faces the challenge of having to revise his course considerably. If many have sufficient interest and energy, we may look forward to students in more advanced courses with greatly improved backgrounds.

I, or anyone else, might prefer slightly different interpretations of some processes, but it seems picayune to fault a text with which I am in such complete agreement and would adopt enthusiastically should I return to teaching elementary geology. In future printings, it might be desirable to enlarge slightly the numbers used to identify individual formations in the Grand Canyon and elsewhere.

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Radiation Heat Transfer

In recent years, under the stimulus of the space program, there has been a growing interest in radiation heat transfer. Since the publication of the second volume of *Heat Transfer* by the late Max Jakob (Wiley, New York, 1957), no comprehensive account of the theories and experiments connected with this subject has been available. To a limited extent, **Engineering Radiation Heat Transfer**, by J. A. Wiebelt (Holt, Rinehart, and Winston, New York, 1966. 278 pp. $9.50), provides such an account.

The book covers the following four major topics: thermal radiation laws, the radiation properties of opaque surfaces, radiation interchange between various types of surfaces separated by a diathermanous medium, and radiation heat transfer in gases. The presentation on the first three topics is satisfactory, although rather brief and somewhat limited in scope. The chapter on gaseous radiation is disappointing. This subject is not readily accessible to the engineer because of the special notation and nomenclature developed over the years by the physicists and chemists; therefore a chapter introducing the basic physics of gaseous emission and absorption would have been most helpful. The author discusses, in some detail, the gray gas and band approximations for an isothermal gas, but the technically important case of the nonisothermal gas is treated only very briefly. The book closes with a useful chapter on radiation equipment.

Problems and exercises are provided for each chapter except the last. A number of appendixes giving radiation properties, configuration factors, and digital computer procedures applicable to radiation problems are provided. Printing, binding, and general appearance of the book are excellent.

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