teria. Reduced manganese occurs more commonly in aerobic portions of the biosphere than reduced iron, and it is a potential energy source for lithotrophic organisms, though there is now no incontestable case of manganese lithotrophy.

In an excellent review of the involvement of microorganisms in weathering processes, Berthelin discusses microbial mechanisms that influence weathering processes, the importance of microbial weathering in soil formation, plant growth, and leaching, and laboratory and field methods for the measurement of weathering.

I was somewhat surprised by the attention given to evolution in the book. Much of a chapter on carbon cycling by Krumbein and Swart is devoted to the topic, and the concluding chapter by Knoll and Awramik discusses ancient microbial ecosystems.

The book was conceived as a textbook, although, as Krumbein notes, it is not a comprehensive treatment of the subject. It would be most appropriate for those who already have a background in microbiology.

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Oxygen Metabolism

The Biology and Chemistry of Active Oxygen. J. V. BANNISTER and W. H. BANNISTER, Eds. Elsevier, New York, 1984. xiv, 262 pp., illus. $55. Developments in Biochemistry, vol. 26.

The editors have used the term "active oxygen" in the title of this book to signify the dichotomous nature of the molecule, a sine qua non for the existence of most organisms and a potential toxicant for all forms of life. The molecular mechanisms involved in the uptake and utilization of oxygen in its beneficial role have been extensively studied, generating a vast body of sometimes controversial information. On the other hand, the basis for deleterious effects of oxygen has only recently been amenable to systematic study and is now the subject of scientific debate, and sometimes of impassioned polemics. The most crucial recent development in the field of oxygen metabolism has been the discovery of the enzyme superoxide dismutase, an event that created widespread interest in the study of the radicals generated in the process of oxygen metabolism. In view of this, and of the involvement of the editors in investigations of the chemistry and biology of superoxide dismutase, it is no surprise that oxygen radicals and superoxide dismutase are the focal points of the book. Subserving this theme are chapters on such topics as the binding of oxygen to hemoglobin, oxygen-using enzyme systems, and the possible role of radicals in disease. Most of the chapters are in the style of synopses of the history, chemistry, and biology of the topics being discussed. For example, the chapter on hemoglobin, by Brunori, Giacometti, and Giardina, starts off with the early studies of Hill and Adair, presents brief descriptions of the models for cooperativity and the phenomenology of regulation of oxygen binding, and concludes with a short section on the comparative aspects of the biology of hemoglobin. This is a very good summary indeed, but it is likely to be old hat for those actively working on the subject.

The chapters on oxygen-using reactions include descriptions of cytochrome *c* oxidase, eicosanoid production, and mono- and dioxygenases. It would appear that the main purpose of these chapters is to provide a backdrop for the ensuing coverage of superoxide dismutase and oxygen radicals. It is therefore surprising that the hydrogen peroxide–producing oxidases such as flavoproteins and metalloenzymes, which are the most likely candidates to generate superoxide radicals, have been completely ignored. Ironically, xanthine oxidase, which was the first enzyme shown to produce superoxide, has often been invoked as an in vivo generator of the radical. The editors have also chosen to ignore catalases and peroxidases, which are ubiquitous and have important biological functions.

The major part of the book deals with the biological effects of reduced oxygen species and the role of superoxide dismutase in protecting against oxygen toxicity. An impressive body of arguments is presented here to support the contention that the superoxide ion is capable of initiating cell damage, often by leading to the formation of the hydroxide radical. Though it is probably true that many intracellular macro- and micromolecules are impervious to the superoxide ion, the catalyzed formation of the hydroxide radical from superoxide and hydrogen peroxide is currently the favored mechanism for explaining the toxicity of oxygen metabolites. Those who would contend that the superoxide radical is innocuous will find little comfort here.

The highlight of the book is a chapter by J. V. Bannister and G. Rotilio summarizing a decade of research on superoxide dismutase, with 291 references. The only shortcoming of this chapter is that it was completed about two years ago, and thus does not cover the results from the recent crystallographic and topological studies that provide an esthetically pleasing idea of the structure-activity correlations of superoxide dismutase.

Despite some shortcomings, this book can be a useful acquisition for those working on oxygen metabolism. With oxygen radicals being implicated in an ever-increasing number of biological pathways, some functional and others detrimental, the audience for a book like this must be quite large indeed.

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Theoretical Seismology

Seismic Wave Propagation in Stratified Media. B. L. N. KENNETT. Cambridge University Press, New York, 1983. x, 342 pp., illus. $59.50. Cambridge Monographs on Mechanics and Applied Mathematics.

Several excellent books in theoretical seismology have in recent years attempted to assume the mantle of Ewing, Jardetzky, and Press's *Elastic Waves in Layered Media* (1957), which played a key role in initiating and disseminating the ideas that now form the theoretical basis for much of seismology. The great expansion of theoretical seismology, associated with the extensive application of wave propagation theory to numerical modeling and inversion, has made the idea of a single successor book to Ewing, Jardetzky, and Press seem quite impractical, however, and recent books by Aki and Richards, Pilant, and Ben-Menahem and Singh have undertaken systematic expositions of wave propagation theory from quite distinct points of view. The sheer volume of material now available makes it necessary for the apprentice seismologist to receive substantial guidance from an experienced professional.

In spite of the number of other books available, the new contribution by Brian Kennett is welcome and fills a significant niche. By restricting the discussion to media with properties depending only on one space variable, Kennett can bring us a systematic, monographic approach while offering informal discussions of the physical significance of the material. The conventional approach to this material involves a rather immiscible combination of scalar wave propagation theory, vector wave theory, and the theory

based on state vectors and propagator matrixes. The last of these theories lies at the heart of most numerical realizations of theory and has become a necessary part of the background of people involved with computer implementation of elastic wave theory. By basing his monograph on this theory, Kennett has done a great service, both to theoreticians and to applied seismologists. The notation is consistent throughout, and the topics are taken up systematically. Throughout are readable discussions of important practical issues regarding computation of synthetic seismograms and the nature of observed seismograms. Kennett's own important recent contributions on the use of 2×2 reflectivity matrixes appear here in context and are substantially more bug-free and understandable than his original journal articles on the subject. Many topics not normally carried through in the context of propagator theory are taken up, such as source representation theory and generalized ray theory. Expansions and approximations of the response integrals are described, with careful attention to explanation of the physical significance of these computationally important expressions, including ray expansions, mode expansions, and partial ray-mode expansions. Some important very recent material, based on the so-called p-tau or slant-stack methods, is absent for reasons of timing.

The compactness and sense of a seamless whole that characterize this book are achieved at some cost to the serious reader. The steps in many important derivations are missing, which will be an occasion for assigned homework in graduate courses. The complexity of the material demands a fairly populous bestiary of boldface symbols and subscripts; the frequent practice of tersely writing an equation to define a new symbol leads to confusion, for the innocent reader may be led on a long chase through preceding chapters to determine where the symbol is first introduced. Perhaps a philosophically minded programmer will write "Commentaries on Kennett, with computer programs" and provide some of the signposts that are missing.

The book is strongly recommended for the collection of every practicing seismologist and graduate student, despite its slight, unavoidable shortcomings. Though not suitable for a first graduate course in wave propagation, it would be an excellent monograph for intermediate or advanced courses. It will be of real interest to prospective authors that Kennett essentially produced the entire book himself, through the popular "troff" typesetting utility on the UNIX operating system. The ease with which it was possible to fine tune the standard macro package to produce a high-quality monograph enjoyable to read should be an encouraging example in technical publishing.

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