BOOK REVIEWS

H. D. Holland, *The Chemical Evolution of the Atmosphere and Oceans*, Princeton University Press, 1984, 582 pp., Cloth, $97.50; Paperback, $24.50.

The properties of the atmosphere and oceans during various periods in the history of the Earth – and the nature and rate of temporal variations in those properties – are of profound significance to any investigator attempting to understand the history of our planet. Thus the evolutionary biologist and the paleontologist are concerned both with the implications of atmospheric and oceanic composition for the origin and evolution of life and with the effects those organisms have on the Earth's volatile inventory. The geologist is concerned with these properties as major factors in determining mineral stabilities, in controlling the rate and type of chemical weathering, and in establishing the types of sediments which will be deposited. Variations in atmospheric and oceanic properties have been invoked to account for the appearance or the extinction of classes of organisms, for the evolution of specific adaptations, and for the presence or absence of certain types of ore bodies and rock types during various geologic periods. Testing the validity of such models requires a level of knowledge of the paleo-atmosphere and paleo-ocean which is often beyond the expertise the scientist who is not a specialist in such matters.

The author has, thus, set himself a formidable task, that of summarizing, evaluating, and synthesizing the large – but often incomplete and ambiguous – body of relevant data concerning the composition, density or extent, sources, sinks, buffers, and diagnostic signatures for the properties of the atmosphere and oceans through geologic time; and to do so in such a manner as to both accurately reflect the present state of the art while also communicating a useful understanding to the geologist, paleontologist, and the evolutionary biologist who is not an expert in this area.

The text is divided into nine sections, which: (1) define our present knowledge and conjecture concerning the initial conditions on the primordial Earth during the final stages of accretion and in the period immediately following accretion; (2) review the constraints on the sources and compositions of inputs to the earliest atmosphere; (3) describe the release and recycling of volatiles and the change in these processes during Earth's history; (4) discuss the inferred chemistry of the earliest atmosphere and oceans; (5) outline sources and sinks of elements and compounds as determined by reactions between these volatiles and the crust; (6) summarize the compositional and isotopic effects of oceanic composition and cycling of seawater through the mid-ocean rift system on the clay and carbonate minerals which comprise much of sedimentary rocks in the geological record; (7) evaluate the constraints placed on the oxygen content of the Precambrian atmosphere by terrestrial deposits; and (8) by marine deposits; and (9) review the evidence concerning changes in the composition of the atmosphere and oceans since the Precambrian.

Large portions of the text are devoted to rather detailed discussions of specific chemical processes, equilibria, and systems involved in the various atmospheric-oceanic-crustal cycles. The non-specialist might reasonably worry about being overwhelmed by a plethora of esoterica expressed as equations, phase diagrams, and tables. The author has, however, rescued these readers with clear statements and summaries of the significance, implications, and limitations of each topic. And throughout, the author casts a refreshingly critical eye over the precision and accuracy of such models, and clearly spells out the realistic uncertainties associated with each.

The text is dense, packed with data, details, and references for the specialist, and with concise and clear synopses for the non-specialist. This volume should be an important addition to the reference shelf of any scientist involved in unraveling the evolution of the Earth's ocean, atmosphere, and/or crust or of the biological system therein.

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Yehuda Cohen, Richard W. Castenholz, and Harlyn O. Halvorson (eds.), *Microbial Mats: Stromatolites*, MBL Lectures in Biology, Volume 3, Alan R. Liss, Inc., New York, 516 pp., $88.00.

The 25 typescript chapters that comprise this book are based on the proceedings of the Integrated Approach to the Study of Microbial Mats, July 26–31, 1982, sponsored by the Microbial Ecology curriculum of the Marine Biological Laboratory, Woods Hole, Massachusetts.

One of the marvels of modern science over the past 20 years has been the unraveling of the early evolutionary stages on the planet Earth as represented by the precambrian fossil record. It is a story that would not have been understood before the advent of modern biology and an extensive understanding of the molecular intricacies of microbial physiology. Moreover, it is a story which could not have been told without numerous, collaborative efforts of geologists, ecologists, marine biologists, microbiologists, and paleontologists.

Microbial mats play a key role in understanding the initial steps of the evolutionary process on earth. It is now thought that during the Archean and Proterozoic periods, microbial mats were responsible for the primordial oxygen build-up in the atmosphere enabling the evolution of higher life forms. They exist today in favored, select habitats worldwide analogous to evidence of their presence in precambian rock formations, also found worldwide.

The book is divided into five sections: community structures and primary production, decomposition of microbial mats, biogeochemical changes of microbial mats with time, evolutionary aspects of microbial mats and possible global impact, and the interdisciplinary approach to the study of microbial mats – perspectives for future research. Each section is followed by a discussion of the significance of the various

topics presented in that section. Topics in the first section include a chapter on ancient stromatolites, an examination of the major cyanobacterial mat formations which currently exist and their fine structure, animal communities in recent potential stromatolites of hypersaline origin and an extraordinary account by Holger Jannasch of the chemosynthetic microbial mats of deep ocean hydrothermal vents. A chapter by Niels Revsbech and David Ward presents the design and research capabilities of microelectrodes to probe the various biochemistries occurring in layers within the mats themselves.

The second and third sections examine the various degradative processes occurring in microbial mats and their relationship to hydrogen, carbon, and sulfur cycling in mat-related environments such as salt marshes and marine sediments and in mats of differing origins such as those found in thermal hot springs and the hypersaline Solar Lake. A chapter by Harry Peck and Martin Odom presents evidence for a new energy coupling mechanism in *Desulfovibrio*, an anaerobic bacterial group found in association with cyanobacterial mats. A concise discussion of the time-related biochemical changes occurring in microbial mats by Jaap Boon concludes these sections.

The remaining sections review the evolutionary aspects of microbial mats regarding possible global impact and the necessary interdisciplinary approach to future studies of cyanobacterial mats. Topics examine the evolution of the microbial mat community and its relationship to atmospheric effects. A chapter by Hyman Hartman speculates on banded iron formations concerning the evolution of photosynthesis and microbial mats.

This volume is the first to describe the history, ecology, and physiology of microbial mats. It represents a composite study of current research efforts worldwide with studies being conducted at Shark Bay, Western Australia; Spencer Gulf, South Australia; Solar Lake, Sinai; Baja California, Mexico; Yellowstone National Park, U.S.A.; as well as deep sea hot vents in the Pacific Ocean.

Representing a who's who in microbial stromatolite mat research, this book could be rightly considered a landmark in this new field which has promoted a highly successful and productive interdisciplinary approach which covers the entire spectrum of atmospheric science, biochemistry, geology, microbiology, micropaleontology, and molecular biology.

This book is well edited and nicely printed on quality paper and typeset. It was meant to become a landmark edition on the subject. There are numerous explicitive figures and photographs and an index. Each chapter has an extensive current reference section. It is recommended reading for all interested in the current development of stromatolite mat formation and the provocative implications these mats have for their analogous counterparts over a billion years ago.

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