BOOK REVIEWS

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GEORGE GAYLORD SIMPSON, PALEONTOLOGIST AND EVOLUTIONIST. *Léo F. Laporte. 2000. Columbia University Press, New York. 332 p. Hardcover, $50.00; Softcover, $16.00.*

George Gaylord Simpson was, beyond doubt, one of the foremost paleontologists of twentieth century. His concepts of evolution, based upon critical reading of earlier literature (in particular, Darwin's writings) and developed through his researches on fossil, Tertiary mammals, had a profound influence on the thinking of biologists and pre-historians. It also caused his fellow paleontologists to give more serious consideration to the operations of evolutionary processes. It is understandable, therefore, that Léo Laporte, a geologist with a strong interest in the history of his discipline, should have found Simpson worthy of extended attention:

> As a paleontologist I had read most of his books, many of his articles, and a few of his monographs. My curiosity was thus piqued to learn more about how his theories developed, how his arguments were constructed, and from what specific knowledge they proceeded. At the time, there was very little literature analyzing Simpson's work and, as I came to discover, most was superficial and concerned with just a few aspects of his voluminous research. Occasionally too, authors couldn't resist the temptation to trivialise his accomplishments, if only to aggrandise their own efforts. (p. xi)

Initially, Laporte intended to write a biography of Simpson but as he writes:

> The concept of the book . . . evolved from conventional biography to a case of "reverse engineering," where one dismantles an object of interest into its constituent parts to understand how it is constructed and the way it works. The book now before you, therefore, is not biographical in the ordinary and strict sense. However, it does progress more or less chronologically through Simpson's life, focusing on major aspects of his research (fossil mammals, evolutionary theory, biogeography, taxonomy and systematics), his ways of approaching scientific problems (continental drift, visual way of thinking), and his impact on related disciplines (biology and physical anthropology). (p. xii)

Laporte makes it clear, moreover, that he felt a biography was not needed after Simpson had published his autobiography, *Concession to the Improbable* (1978). However, I suspect that a secondary reason for Laporte's decision may have been the fact that Simpson, though so brilliant a scientist, was an uncomfortable sort of creature, too self-focussed to relate well to other members of humankind. He disliked teaching (p. 252) and was a failure as an administrator (pp. 247–249). As Laporte writes:

> In short, he not only was a difficult person to deal with but he had no interest in dealing with people. His genuine scientific achievements and the very visible rewards that came with them also seemed to encourage an attitude that he was always in the right, justifiably so or not. (p. 255)

Laporte's approach thus does not allow an extended presentation of biographical details, but Simpson's life is summarised in an introductory chapter and forms a leitmotiv to the following text, also gaining extended treatment in the two concluding chapters. The difficulties of a too-hasty first marriage to a woman with mental problems (pp. 5, 8) and, when that marriage broke up, of variable relations

with his four daughters (p. 9), were to be very largely compensated by a successful second marriage to a much more congenial companion. Even so, it is clear that Simpson was rarely happy.

Beyond question, it was Charles Darwin's concepts that most profoundly influenced Simpson's scientific and philosophical thinking. Like Darwin, Simpson found himself uncomfortable within the framework of conventional Christian religion, adopting instead "a positivistic philosophy" (p. 77). Yet, towards the end of his life, Simpson subsided into melancholia and pessimism—a pessimism that is intrinsic, as Laporte shows (chapter 12), to his posthumously published novel of time-travel into the Mesozoic, *The Dechronization of Sam Magruder* (1996). Did this result from a belated awareness of his failures as a human being or was it a product of his rejection of Christianity, without ever finding a substitute? Both seem likely. As Laporte writes:

> Outwardly, he seemed coldly rational, aloof, preoccupied, always intently focused on his scholarly work, with little obvious interest in introspection, whether personal or much less that of others. Yet he obviously bore the universal human anxieties regarding the meaning and purpose of existence. (p. 266)

Whatever his personal shortcomings, Simpson's scientific achievements were very considerable. The prime novelty was his approach to the analysis of fossil faunas:

> For Simpson . . . , species were to be conceived not simply as abstractions to be defined and identified, but instead as biological entities representing populations of organisms dynamically interacting with their local environment. (p. 93)

Nowadays, such an approach causes no surprise. But at a time when collection and description were considered by most paleontologists to be all that was needful, it was remarkable. Its effect was to bring paleontology into its proper place within the mainstream of evolutionary biology (p. 107).

The unity of evolutionary processes was a matter stressed by Simpson (p. 109), as was the link between paleontology and genetics (p. 143). In addition, Simpson recognized that evolution had proceeded at different rates in different lineages: slowly in many bivalves, at a steady rate in Tertiary mammals, and at a high rate for short periods in certain other groups. He coined the terms *bradytely, horotely,* and *tachytely* for these different rates (p. 146). His concept of the "adaptive zone," determined not only by physical conditions but also by biological circumstances and the innate qualities of the individual organism (pp. 152–153), caused him to recognize an "adaptive grid" within which "the course of adaptive history may be pictorialized as a mobile series of ecological zones, with time as one dimension." (p. 153)

Pictorializing was indeed one of the attributes of Simpson's approach; he delighted in presenting his concepts in diagrammatic form. Laporte discusses this aspect of his work at length in chapter 10, "The Mind's Eye." He comments:

> For Simpson the visual was both an "effect," that is, something that supports a general design or intention, and an "affect," that is, an emotion as distinguished from cognition, thought, or action. (p. 222)

Since this reviewer is one of those who, in Simpson's words, "deal with theoretical or abstract concepts in other forms" (quoted pp. 221–222), his diagrams have hindered, rather than helped, my own comprehension of his ideas; but I do not doubt that there are others for whom "analogical diagrams . . . proved to be enlightening" (pp. 221–222).

It is, of course, from the expounding and analysis of Simpson's concepts that this book draws its strength—but also its principal weakness, since the fact that it is based upon earlier, separate papers involves considerable repetition. For ex-

ample, Simpson's book *Tempo and Mode in Evolution* gains not only a full-scale assessment in chapter 7, but also extended mentions in several other chapters.

While I do not fault Laporte's judgement that Simpson's concepts of paleogeography proved fallacious—Laporte's chapter concerning them is appropriately titled "Wrong for the Right Reasons"—I do not accept the assumption therein that continental drift and plate tectonics are synonymous. Simpson was right in rejecting the former and was not being inconsistent when he accepted the latter. Neither do I believe in "the Late Mesozoic mass extinction of reptiles" (p. 161); as I have recently striven jointly to demonstrate, the so-called Great Extinction was merely a rather damp evolutionary squib (see Sarjeant and Currie, *Canadian Journal of Earth Science,* 2001, 38:239–247). As for the claim that the "whole scheme [of taxonomic nomenclature] collapsed like a house of cards" when Simpson published his "epoch-making papers on 'Types in Modern Taxonomy'" (p. 35), it is simply not true: the identification of species—in paleontology at least, and even very largely in neontology—continues to be based upon comparison of other specimens with a type specimen or series.

Checking of the text has been so commendably thorough that I noted only one typographical error (vis-Ö-vis, p. 258). The typography is easily legible and the reproduction of photographs adequate, though a few (e.g., Figure 1.3) are rather too grey. All in all, this is an attractively produced book, presenting an extended and useful analysis of George Gaylord Simpson's accomplishments and influence. It is surely destined to become a standard reference text on a man who the author properly characterises (p. 245) as "one of the leading scientists of the middle half of the twentieth century."

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SMITHSONIAN INSTITUTION SECRETARY, CHARLES DOOLITTLE WALCOTT. *Ellis L. Yochelson. 2001. Kent State University Press. 589 p. Hardcover. $49*

This second volume of Yochelson's biography of Charles Doolittle Walcott (1850–1927) begins where the first one ended, with Walcott's appointment in 1907 as secretary of the Smithsonian Institution, a position he occupied until his death in 1927. As he had done as head of the U.S. Geological Survey from 1894 until 1907, he brought new strength to the institution and presided over many important developments in its service to science.

I'm sorry to say, however, that it takes some digging to sort out the important from the trivial. The book has the same frustrations for the reader as the first volume, *Charles Doolittle Walcott, Paleontologist* (Kent State, 1998). It is too tied to the day-to-day events of Walcott's life. As Yochelson says (p. 435), "one can develop a biography thematically or chronologically; though Walcott had many irons in the fire, the latter approach seemed most liquid." Most readers will wish for a fuller attempt to identify and develop the themes that dominated Walcott's life, although Yochelson does try to do this in a series of epilogues. Even the chapter headings are not very illuminating: e.g., "The Kindly Years (1907–1910)," "The Dreadful Years (1911–1913)," when he lost his wife and a son, "The Frantic Years (1917–1919)," and so on.

Paleontology was Walcott's first love, and even as a busy administrator he found time to continue the work on the Cambrian trilobites of the Canadian Rockies that he had begun much earlier and about which Yochelson writes in the

first volume. But as Smithsonian secretary he necessarily became involved in many other scientific, technical, and cultural fields, including the building of the Freer Gallery of Art.

As successor to Smithsonian secretary Samuel P. Langley, who first involved the institution in developing a flying machine, Walcott felt strongly that the government should support research in aviation. During World War One he played an important role in the founding of the National Advisory Committee for Aeronautics, the precursor of NASA, and was its chairman until his death. He also obtained support for the revival of Langley's laboratory for aviation research. His support of NACA was somewhat overshadowed, however, by the controversy over the Wright brothers' claim to priority in flight. Walcott had the Langley aerodrome, which had crashed into the Potomac River on its trial flight shortly before the Wrights' successful flight, shipped to Glenn Curtiss's factory in Hammondsport, New York, for restoration and testing. When the tests proved that the aerodrome could fly, Walcott had the plane displayed in the Smithsonian with a label that indicated it had been the first plane capable of flight, a claim contested by the surviving Wright brother, Orville, who threatened to send their plane to a London museum. The newspapers publicized the controversy and Walcott tried to smooth things over, but he and the Smithsonian were subjected to considerable criticism.

Yochelson makes clear what a busy person Walcott was. He chaired committees efficiently, reported to Congress (he was good at getting appropriations), lunched occasionally with the American president (he got on better with Teddy Roosevelt than with Woodrow Wilson), was actively involved with the activities of the Carnegie Institution of Washington (he had a strong influence on its founder), and served for several years as president of the National Academy of Sciences and the American Association for the Advancement of Science. He was an energetic and efficient administrator who apparently couldn't say no.

Every summer Walcott returned to the Canadian Rockies for more Cambrian fossils to add to the Smithsonian's already large collections. Somehow he managed to schedule time to study and write yearly reports on his trilobites, published with elaborate illustrations in *Smithsonian Miscellaneous Collections.* His collections from the Burgess Shale, which Yochelson calls the "single most important fossil find ever made," (p. 49) have since been restudied. They became the subject of controversy when Stephen Jay Gould, writing in *Wonderful Life* (1989), accused Walcott of "shoehorning" the amazing new variety of life forms he had found into existing groups in the classification system. Walcott was too conservative, Gould said, to recognize that the explosion of life forms represented entirely new classes. Yochelson replies to some of Gould's accusations in his epilogues, defending Walcott and rejecting any suggestion that his scientific work was affected by his religious or any other views of life.

In spite of its drawbacks in matters of style, the book provides a picture of an active, energetic man devoted to family and work. After his second wife Helen died in a train accident, he married Mary Vaux, a geographer and botanical illustrator who accompanied him, as his children often did, on his summer fossil collecting expeditions and served as his hostess at Washington events. Yochelson's dedication to his subject is obvious—he is the whole Walcott industry, he says, as his is the first and only biography of Walcott to date. But with a bit less attention given to the timeline and more to following through on important events as they occurred, it might have been a better book.

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CALIFORNIA EARTHQUAKES: SCIENCE, RISK, AND THE POLITICS OF HAZARD MITIGATION. *Carl-Henry Geschwind. 2001. Johns Hopkins University Press, Baltimore and London. 337 p. Hardcover, $45.00*

I enjoyed reading this valuable book. My career as professor of seismology at the University of California, Berkeley, from 1963 to 1992, director of the university's Seismographic Stations for twenty-seven years, and a member of the Seismic Safety Commission for fifteen years, coincided with the latter period so ably presented here, particularly chapters six to nine. As a consequence, much of the book is close to home and the subject of personal checks and recollections. There is a short introduction that goes back to earlier studies of earthquakes, but the detailed coverage spans the interval from the 1906 San Francisco earthquake to the 1989 Loma Prieta earthquake with some treatment later. Geschwind has well synthesized the large amount of historical material. As a bonus, there is unobtrusive documentation of lasting value to students fascinated by the interaction of science and government.

The author embeds his historical account in a theoretical framework: "the regulatory-state apparatus in California is an outgrowth of the ideology of Progressivism" (p. 5), but he does not expand this theoretical argument very far and it remains undeveloped as an underpinning. Yet, by the end of the book it is clear enough that the evolution of earthquake hazard mitigation in California is "not a simply story of response to natural disasters: also important is the degree to which mitigation advocates have organized and had the resources necessary to mobilize public opinion for the political process in pursuit of their goals" (p. 229).

Reactions to the 1906 San Francisco earthquake and fire set the stage for so much of the subsequent history. In the early chapters, the historical research is comprehensive, with critical coverage of the principal issues and controversies. Incompleteness occurs only because accessibility and even existence of primary sources is uneven. The problem is defined in the "Essay on Sources" (pp. 317–322). Chapter two, which deals with building the necessary scientific infrastructure in California from 1920 to 1925, illustrates the "great men" approach to history favored by the author. The seminal importance of the *Report of the State Earthquake Investigation Commission* and the formation of the Seismological Society of America are explained by detailing the crucial contributions of G. K. Gilbert, Harry Wood, and Andrew C. Lawson, among others. The evolution of the 1920s emphasizes the role that Bailey Willis of Stanford University played through his indefatigable campaign for public and government attention to earthquake hazard in California. Willis's proselytizing is balanced by a wild prediction (pp. 84–86) that brought his reputation down. One anecdote not told is the split opinion between Willis and Lawson concerning the safety of the south tower of the proposed Golden Gate Bridge. Lawson carried the day.

From the 1930s, the highlight is the state response to the 1933 Long Beach earthquake. The public saw school damage as an unacceptable danger to children. Boosters against state regulation were quieted, and Geschwind documents the birth of the Field Act, the beginning of the end of effective opposition to state government intervention on public seismic safety.

Chapter five switches to the post-World-War-II revolution in seismology. In the pre-war decades most developments were state or privately funded. Post-war modernization of the earthquake sciences was the result of federal government funding for research and better seismographs in an attempt to underpin a verifiable and comprehensive test ban treaty. The author notes the consequent changes in the membership of the Seismological Society of America and the members' new

emphasis on seismic wave theory. One early advance was the installation in 1961 of the first telemetry network of seismographs, operated along the San Andreas fault in central California by the University of California, Berkeley. (The sequence of seismographic station upgrades and development of the San Andreas Geophysical Observatory (p. 149) is not quite accurate in the book. The reader is referred to exhaustive surveys in J. J. Liteheiser, ed., *Observatory Seismology,* Berkeley, California: California University Press, 1989.) [This book was reviewed in *EARTH SCIENCES HISTORY,* 1992, 11/2.—Ed.]

In chapter six, we come to a much broader and more splintered era of the study of California earthquakes and their hazards. A seminal stimulus was the U.S. reaction to a major Japanese report on earthquake prediction in 1965. A lobby for a U.S. program formed around Frank Press, director of Cal Tech's Seismological Laboratory from 1957 to 1965 and later President Carter's science advisor. The scientific justification was that any science without a predictive capability must be regarded as weak. The ups and downs of this try for enhanced federal funding for earthquake studies is well worth reading. But there are other fascinating case histories covered in this period. One concerns the effort of utility companies in California to build nuclear power plants. For example, the Pacific Gas and Electric Company (PG&E) chose a sequence of plant sites along the coast north of San Francisco and hence adjacent to the San Andreas fault. The first site was at Bodega Bay and the drama of the personal debates that arose on licensing this site is told in some detail. "In the end, the seismic safety issue killed PG&E's proposal" (p. 136). The full story of the final approval of the PG&E's invaluable power station at Diablo Canyon (p. 218) and the critical research on seismic hazards carried out because of the Nuclear Regulatory Commission's stringent licensing requirements remains to be written. Other interesting relevant cases are missed (see R. L. Meehan, *The Atom and the Fault,* MIT Press, 1984).

In chapter eight, the drama of earthquake prediction is revisited in an even-handed way. The criticisms of Richter and others that the program was "pop research" are balanced against the advocates of the program. A key was the reaction from prominent earthquake engineers that expenditures to achieve seismically resistant structures were a more important use of federal funds than a seismological prediction program. The period saw many failed predictions, both in California and other earthquake-vulnerable lands (see R. S. Olson, *The Politics of Earthquake Prediction,* Princeton University Press, 1989). Today the majority expert view is that earthquake prediction in the strict calendar sense is impossible given the complexity of the physical system involved. As I have long pointed out, however, there are two types of prediction: first, forecasting in time and space of the earthquake, of limited value anyway (p. 145); and secondly, estimation of the future ground shaking in a specified earthquake. Indeed, strong-motion seismology addresses this latter problem and has become a dominant part of California seismology.

In the last chapters, appropriate credit is given to two Californians: the late Carl Steinbrugge and the late Senator Alfred E. Alquist. The weight given to them in the book is an appropriate memorial to the remarkable contributions on the policy side made over the years by Steinbrugge and by Alquist on the political side. I suggested to Perry Byerley that Stanley Scott at the Institute of Governmental Studies at U.C. Berkeley ask Steinbrugge to write his influential monograph, *Earthquake Hazards in the San Francisco Bay Area.* Geschwind confirms that this monograph led to the Joint Committee on Public Safety (1969) chaired by Alquist. In turn, the work of the Joint Committee and the 1989 San Fernando earthquake led to Steinbrugge's proposal that Alquist set up the California Seismic Safety Commission, which still functions today.

The account after about the 1989 Loma Prieta earthquake becomes more cursory, no doubt reflecting the diversity of agencies and groups that had become involved. The author's early emphasis on research personalities and groups at universities almost disappears; emphasis focuses on the National Earthquake Hazard Research Program (NEHRP) (post-1977) and the Seismic Safety Commission (post-1975). The author rightly salutes the accomplishment of the Seismic Safety Commission but does not seem to be fully aware of its ups and downs of government support and influence. A more recent, critical component of the ongoing reduction of risk from California earthquakes was the report to the governor following the Loma Prieta earthquake, titled *Competing Against Time* (edited by George W. Housner). It stimulated state support at the top government levels for earthquake hazard reduction in California. It led to the massive Caltrans bridge retrofit program, not yet completed. (Incidentally, political delays in rebuilding the east crossing of the Oakland–San Francisco Bay Bridge have led costs to increase (January 2002) from $1.6 billion to over $2.6 billion) (p. 223).

In summary, the book can be highly recommended to a wide variety of readers. In a broader sense than its earthquake theme, it is an absorbing account of an important component of the development of California. Geschwind writes with an attractive style, some humor, and knows how to thread intriguing anecdotes. His self-imposed historical restraints sometimes lead him to details that the general reader might wish to pass over, but his direct style always brings the reader back to stories of enduring interest.

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LYELL: THE PAST IS THE KEY TO THE PRESENT. *Derek J. Blundell and Andrew C. Scott, eds. 1998. Geological Society [London] Special Publication No. 143. 376 p. Hardcover, £79*

One of the authors of this volume explains how he was drawn into what he justifiably calls the "Lyell history industry" (p. 66). Charles Lyell, who (says another contributor) "As an original, creative and independent thinker . . . stands as the greatest geologist of the nineteenth century," (p. 36) laid the foundations of many areas of geology and his ideas inspired Darwin's ideas of natural selection. Lyell has been well served by the many biographical and historical studies and reprints that have been published in the last few decades, and it might be wondered if there is room for such a volume as this. But it is full of meat, generally readable, and could be taken as a model for such a study on other major figures.

The volume is a compendium of papers read by a group of international scholars at a 1997 conference held to mark the bicentennial of the birth of Lyell. It contains twenty-three papers by twenty-eight authors: from Canada (two), France (one), Italy (two), New Zealand (one), Sweden (one), UK (thirteen), and USA (eight). The volume is arranged in three sections. Seven papers explore the life and influence of Lyell, with fascinating contributions on the *Principles of Geology;* his relationship with the Geological Society; a survey of his life and times; his critical reception in Europe; two papers on his North American travels; and his work on the antiquity of man.

In section two, a further eight papers consider Lyell and the development of geological science. In each, Lyell's views are considered in a changing geological

context. Discussions include Lyell's role in the foundations of sedimentology; in Tertiary stratigraphy; his views on organic evolution and extinction; the age of the Earth; and Quaternary glaciation. [Here it is interesting to see that Lyell backed off in the face of opposition from correct interpretations of glacial drift, for he had "an unusual capacity for suspending judgement in the face of seemingly overwhelming evidence." (p. 65)]. Lyell's views on climatic change include an intriguing anticipation of continental drift in his maps showing theoretical alternative distribution of landmasses and their effects on climate. Inevitably, catastrophism and uniformitarianism are also explored. However, the otherwise interesting hydrogeology section largely documents work by geologists other than Lyell.

In section three, eight papers explore "The Legacy of Lyell," giving modern insights into major problems to which Lyell contributed. The diversity of his interests and his wide ranging influence is well illustrated by papers on tectonic evolution; coal measures and the Carboniferous evolution of Nova Scotia; sequence stratigraphy; salt extrusions in Iran; Mount Etna; earthquakes and Earth's structure; and the impact of humanity on the modern environment.

Extensive illustration (largely in black and white) includes portraits in paint and sculpture; reproductions of title pages and illustrations from books; samples of field notes and sketches; and chronological tables, graphs, sections, and maps (a few of which are surprisingly without orientation or scale). Photographs of varying quality illustrate commemorative plaques and stamps, specimens, and significant sites on Earth—and even on Mars! A few color maps and diagrams clarify geological complexities in one paper.

On the negative side, one author who quotes Lyell at length comments that "Today's models . . . are essentially similar, though with 150 years' worth of additional jargon" (p. 107). Alas, we are forcibly reminded of the extent to which Lyell's lucid language was an important asset, for the same accretion of jargon is present in some of the otherwise most intriguing papers in the third section. This limits their accessibility to those who are not specialists in their fields (unless they are prepared to make constant reference to an up-to-date glossary). There are perhaps more typos than is necessary in these days of computer spelling programs; "Niagra" Falls (p. 78) is perhaps the most glaring.

It would have been useful to have a brief paragraph about each of the contributors, but perhaps the most apparent omission is an overview of the historiography of Lyell and his work in the years since his death, which would have provided valuable background to many of the papers.

Quibbles aside, this volume is an essential resource for all future beneficiaries of—and contributors to—the Lyell industry, and contains much that would benefit anyone interested in geology. It is therefore the more regrettable that its high price will largely restrict it to academic libraries. Would that Lyell had been taken as seriously by those British "experts" who developed an exhibit on time for the millennium, and failed to mention a single geologist among their "time lords."

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MOJSISOVICS ON THE TRIASSIC REEFS OF THE DOLOMITES (1879). *Eberhard Gischler, ed. 2001. Geological Milestones—Vol. V, Comparative Sedimentology Laboratory, University of Miami, Florida. 106 p. Softcover, $10.00 (Available from Robert Ginsburg, Division of Marine Geology and Geophysics, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149; add $2 postage and handling, for a total of $12. Prepaid orders only in U.S. dollars made payable to the University of Miami or by credit card).*

Georg Edmund von Mojsisovics (1839–1907) stands out as a luminary among the great international rock stars of geology. Mojsisovics had a long and illustrious career in the Austrian Geological Survey of Vienna (Geologischen Reichsanstalt). His work, undertaken in the majestic Triassic Dolomites of northern Italy, shows the spark of genius, both in descriptions and interpretation. Among the more than one-hundred-fifty publications to his credit, most of these deal with Triassic stratigraphy, structure, and paleontology of the eastern and southern Alps. Early on in his career, Mojsisovics became fascinated with the Dolomites and he labored to integrate his fossils and fieldwork toward a synthesis of the origin and geologic history of these massive carbonate peaks.

Mojsisovics recognized, one-hundred-twenty years ago, that the Dolomites contain some of the finest examples of Upper Triassic reef facies. Although much of the credit must be given to Ferdinand Freiherr Richthofen (1833–1905), who discovered the reef nature of the Dolomites, it was Mojsisovics who worked out the facies and their stratigraphic relationships, casting them in such innovative contexts that it comes as a surprise to contemporary readers that his ideas and insights emanated from the late-1800s rather than the present. For example, he recognized that corals dominated some of these reefs but that calcareous dasycladacean algae, mollusks, and other benthic invertebrates also made contributions to the carbonate rocks. Mojsisovics's most seminal work on this subject was titled "The Dolomite Reefs of South Tyrol and Venetia. Contributions to the Development of the Alps." This work was published in German in 1879 by Alfred Hölder in Vienna, and stands as one of the classic works on the subject, yet it has remained unavailable to a large segment of non-German readership. The publication of *Mojsisovics on the Triassic Reefs of the Dolomites (1879),* the fifth publication in the "Geological Milestones" series of the University of Miami, has changed all of that. This publication is a lucid translation into English of most of the original, German version. This translation is particularly relevant because it opens Mojsisovics's important work on reefs to wider geological and biological audiences.

The editor, Eberhard Gischler, has done a fine job pulling together diverse aspects of Mojsisovics's life and his work on Triassic reefs. The translations from German to English were done primarily by Gabriela Meyer, but the Miami publication is actually much more than a mere translation. The underlying value of this work also lies in the excellent commentary provided by contemporary experts who not only are knowledgeable on the subject matter, but who also understand the directions of Mojsisovics' ideas. To assist the reader in comprehending more fully the subtleties of certain German words to better grasp the concepts, Alfonso Bosellini, Peter Brack, and Peter Homewood interject comments at the end of each chapter. Relevant portions of text also are highlighted to draw attention to their importance.

The Miami publication begins with a preface and chapters 1–2, dealing with basic introductory material and an overview of biogeography and the dating of the strata. Triassic stratigraphy and the relevant formations of the Alps are in-

cluded in chapter 3, where also the biostratigraphic zonation of rocks in the Alps and the Dolomite reefs is presented. When introduced to the tables and charts of the ammonoid and bivalve zonations, few readers will realize the controversy and the depth of acrimonious debate that once raged from 1892–1902 between Mojsisovics and a contemporary geologist, Alexander Bittner, over the placement of the Carnian vs. Norian stages. Interested readers are referred to E. T. Tozer for a well-written account of this controversy that led to Mojsisovics leaving his position in Vienna (*The Trias and its Ammonoids: The Evolution of a Time Scale,* Geological Survey of Canada, Miscellaneous Report 35, 1984, 171 p.). Chapter 4 addresses the structural geology of the Dolomites and includes some original geologic cross sections.

Chapter 5 is the most relevant for reef workers. It emphasizes Mojsisovics's major findings on reefs and includes thicknesses, reef boundaries, and differences between massive low reef facies and bedded, basinal dolomite, and the nature of the reefs and the composition of the fauna and flora. Mojsisovics, for example, recognized from stratigraphic and sedimentologic relationships that two separate reef intervals existed, one in the Ladinian and another in the Carnian stage of the Upper Triassic. Based on the character of bedded vs. massive dolomite, coupled with the composition of the flora and fauna, he deduced the differences between reefs, with coral faunas, and the rich algal association of the lagoonal facies. He also resolved the nature of the "Cipit" blocks, which consist of material eroded off the reef and tumbled down into the adjacent basin. Mojsisovics was astutely aware of the scientific literature. He thus was quick to tie his observations on the growth and origin of reefs of the Dolomites with influential contributions of his time from Darwin and Dana, both of whom had recently presented some powerful theories on the origin of modern coral reefs.

The Miami publication is graced by reproductions of many of Mojsisovics's original drawings and geological cross sections of the spectacular mountain ranges in the Dolomites. Unfortunately, his original colored geologic maps and descriptions are omitted. An index is also omitted, but the publication contains a detailed table of contents. The editor makes clear from the onset that this translation is not intended to stand as a complete translation of the original but rather focuses on the aspects of the reefs. I recommend this publication not only to scholars of the Triassic but also to paleontologists, stratigraphers, and reef workers wishing to gain an appreciation of ancient reefs. Here, over one-hundred-twenty years later, one can read in English, a great master's words and appreciate his insights into some of the most famous fossil reefs of the world.

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SCIENCE AND ENGINEERING IN IRELAND IN 1798: A TIME OF REVOLUTION. *Patrick N. Wyse Jackson, editor. 2000. Royal Irish Academy, Dublin. 81 p. Soft-cover, EUR6.35*

This small book links snapshots of the biology, chemistry, geology, and engineering of the day to the exigencies of the Irish political situation in 1798. In the decades that saw revolution in the United States and France, Ireland attempted, unsuccessfully, to overthrow English rule via rebellion, with the aid of a French invasion fleet. The status of men of science with respect to revolutionary activities naturally influenced their activities and opportunities within science. However, some of those profiled owe more to England and America for their

sphere of activities, this fact itself a product of the political times. The five chapters include one for biology, two for chemistry, one for geology, and one titled "Science, Engineering, and the Military in Ireland."

In the first, Peter Bowler points out that this was an age of scientific as well as political revolution, and his contention is that one aids the other. Although his biologist, Richard Lovell Edgeworth (1744–1817), opposed the Irish rebellion of 1798, he was in correspondence with Erasmus Darwin and others of the Lunar Society of Birmingham whom we now associate with revolutionary science. Bowler sees this time as the beginning of the overthrow of the static notion of nature. In terms of contributions to science, Edgeworth was a marginal figure, more noted for his enlightened approach to managing his farms, and some inventions, than to any change of ideas in science. He is also discussed in the last chapter in this volume in conjunction with his work with transport.

The Ireland of the chemist William James MacNeven (1763–1841) was a country only recently visited by the Enlightenment. Although Robert Boyle was Irish, his work had been done elsewhere, while supported by income from his Irish estates. MacNeven was Irish and Catholic, educated abroad. He was active in the Irish rebellion of 1798, having returned to Ireland as a medical doctor and begun a practice, as well as doing some publishing in science. His political activities led to imprisonment and then deportation. He eventually took up residence in the United States, where he was a medical doctor and a chemist. Even though he published in chemistry in the following years and was credited with the first teaching laboratory in New York, his life is less instructive as that of a scientist than as an example of the trajectory of a rebellious Catholic Irishman. Reasons for inclusion of another chemist, John Patten Emmett (1796–1842), in this volume escape me. Born in Dublin, he was two years old at the time of the rebellion. Emmett worked in the U.S., where he is considered to have made some contributions to chemistry.

The chapter of most interest for HESS readers will be that of Patrick Wyse Jackson on the basalt controversy as it was played out in Ireland and, from a wider standpoint, from evidence seen in Ireland but often interpreted by outsiders. One notable exception to that was the Irish Neptunist, Richard Kirwan (1733–1812), known for his disagreement with James Hutton. Wyse Jackson placed the account in the context of the development of science and scientific institutions in general, and geology in particular, in Ireland, with notes on scientists of the day. It is unfortunate that one of several errors with respect to dates is made in this section. The author indicated the significance of Giant's Causeway to interpretations of the origin of basalt. Since relatively few of the major figures in the dispute actually traveled to Ireland to observe, the importance of a series of paintings by Susanna Drury, which were subsequently widely disseminated as engravings, was noted. However, the date of the paintings was given as 1840, which is a number of years after the demise of the scientists supposedly influenced by them. The correct date was 1740. In any case, this is a good capsule treatment of a segment of a major geological problem.

The final chapter showed the links not only between science, engineering, and the military in the Ireland of the late eighteenth century, but also the rise of civil engineering, its relation to science, and connections between England, the Continent, and Ireland. The need for canals, bridges, roads, and defense was addressed by a cadre of a few Irish and more British practitioners. The chapter is of interest for providing social background for the technology of a somewhat unfamiliar time and place.

And that is what recommends this publication. It places people and ideas in the social context of a place, time, and activity (the 1798 Irish rebellion) that is

not familiar to many who work in the history of science, and as well provides a somewhat different look at the basalt controversy from an Irish standpoint.

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THE OXFORD COMPANION TO THE EARTH. *Paul N. Hancock and Brian J. Skinner, eds., with David L. Dineley, associate editor. 2000. Oxford University Press, Oxford and New York. 1174 p. Hardcover, $75.00.*

When a book title begins with "The Oxford Companion," one thinks of a "literary companion" to every subject from the Bible to twentieth-century literature. Now the Oxford University Press has added *The Oxford Companion to the Earth* to its prestigious list of titles. And a most worthy addition it is. The list of contributors, over two hundred in number, fills four pages. Editors Paul Hancock and David Dineley (University of Bristol, UK) and Brian Skinner (Yale University) deserve high marks for this monumental work.

The preface states its aim as follows: "Like other Oxford companions, it is aimed at a wide readership. It is our hope that it will appeal to everyone, but especially to those with a concern for the environment; to those who simply wish to know more about planet Earth; and to students in the Earth sciences. We also hope that [the book] will appeal to professional scientists seeking an accessible digest of topics outside their own areas of specialization; to those working in fields concerned with the issues of resources and the environment, such as town planners, civil engineers, administrators, and politicians; and to all those, whether in schools or higher education, who are studying or teaching the Earth sciences and related subjects, such as geography and environmental science."

After the preface, a "Note to the Reader" discusses how to use the book. There are two ways to look up a subject: from a regular index and from a group of thematic lists. Four appendices include 1) geologic time scales; 2) Earth and solar system data; 3) the periodic table; and 4) scientific units and notation, abbreviations, and conversion tables.

Also included is a tribute by associate editor David Dineley to senior editor Paul N. Hancock (1937–1998) who died before the book's completion. The editing of such a massive amount of material (the book is two-and-a-quarter-inches thick) is an invaluable service to the community. In my opinion, historians should pay attention to this scientific "community service," which is often not given the credit it deserves.

There are some ninety-one biographical entries in this massive work, most of which were written by Dineley. For anyone looking for information on a particular person, they should know that not all of these biographies are listed in the "Historical" thematic list.

In browsing this book, I checked the first entry (acid rain), the last (zoogeomorphology), and one at random (magnetic field [origin of the Earth's internal field]), none of which are specialties of mine. I found all of these to be readable and informative. All but the shortest entries contain "further reading" lists.

Categories in this book are often highly unusual. Ecclesiastical geology (p. 292) is not about creationism (which has its own entry on p. 165) but rather about the study of the geology of church masonry. I was a little surprised that geological puns were not mentioned in the entry for "geological humour" (p. 406).

Yes, there are misprints in this volume, the inevitable occupational hazard of putting together a work of this size. The name Milankovich is spelled correctly

in the article on p. 687, but not in the index (p. 1130, where it reads as Minankovich). Under "geological surveys" (p. 412) the founding date of the U.S. Geological Survey (USGS) is erroneously stated as 1889; however, the correct founding date of 1879 is given in the biographical article on John Wesley Powell (p. 897). On p. 625, my copy lacks a completed sentence and the author's name at the end of the entry for Charles Lyell. All of these misprints can easily be corrected in later printings.

The quality of the black-and-white diagrams and photographs is excellent. The front covers show the distributions of continents through time: going backward from the modern world through the Eocene, Early Jurassic, Late Permian, Early Carboniferous, Late Ordovician, Cambrian, and lastly to the Late Proterozoic. The dust jacket features the ever-popular erupting volcano, which—let's face it—is a guaranteed eye-catcher.

While the relatively high price probably precludes many purchases by individuals, this book definitely belongs in every school and public library.

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HUBBERT'S PEAK: THE IMPENDING WORLD OIL SHORTAGE. *Kenneth S. Deffeyes. 2001. Princeton University Press, Princeton, New Jersey. 224 p. Hardcover, $24.95*

Much of Kenneth Deffeyes's new book is a mildly competent and in places a charmingly chatty introduction to petroleum geology for the lay reader. In several of the early chapters you will find a pleasant and easy-to-read discussion of the origin of oil, a traditional explanation of reservoirs and traps, and an Ivy-League academic view of the United States oil industry as it was in the last few decades of the twentieth century. The lay reader is warned, however, that a number of surprising and idiosyncratic assertions are sprinkled through even the most elementary parts of the text. For example, Deffeyes gives W. Jason Morgan of Princeton full credit for the discovery of plate tectonics—an assertion somewhat like saying General Montgomery won World War II. Likewise, the only named researchers in oil and gas field finding rates and discovery process modeling are Bill Menard of Scripps and George Zipf of Harvard—also choices that will surprise many specialists in the field.

The first and last five chapters are devoted to the author's musings on the future of fossil fuels. The former professor has decided to use this little book as a platform from which to leap, head first, into the discussion of the energy future of the planet. The bright orange and black dust jacket (the colors of Princeton!), showing the silhouettes of old-fashioned oil derricks against a blazingly beautiful sunset, tells his story. To paraphrase: world oil production will peak within a few years and long-term solutions will not be in place soon enough to avoid catastrophic shortages, soaring prices, and global economic, agricultural, and possibly political disturbances. Astonishingly, Deffeyes even recommends that colleges and universities invest large blocks of their endowments in oil and gas reserves before the big price rise. He laments that "those of us in the middle class have the majority of our assets tied up in home equity and managed retirement funds." Evidently he would have us move our 401K's [American retirement accounts] into oil stocks before it is too late.

M. King Hubbert, for whom the book is titled, was an irascible and brilliant geophysicist with a gift for mathematically characterizing complex processes.

Hubbert worked for Shell Research and then for the United States Geological Survey. He is best known for a 1956 paper published by the American Petroleum Institute. In it, he presented a model of oil depletion based on a symmetrical logistic equation. In his model production begins at zero, rises rapidly to a maximum, and then declines to zero once again as the resource is depleted. The plot resulting from this equation is "Hubbert's Peak."

The equation is straightforward, but the assumptions on which it is based are not. In order for the Hubbert model to successfully predict the depletion of a finite resource, the recoverable volume of that resource must be known and the market into which it is sold must not permit substitutions. Hubbert made several such models based on various assumptions about the ultimate amount of recoverable oil and gas in the United States and in the world. One of the models predicted that maximum oil production in the forty-eight contiguous United States would occur in 1972, close to 1970, the actual year of historic maximum production. Declining U.S. oil production in the early 1970s coincided with the painful OPEC oil embargo of 1973. So Hubbert's place in history was assured.

Deffeyes met Hubbert shortly after graduate school when both of them were working at Shell Research in Houston. The crusty geophysicist made such a lasting impression on the young geologist that forty years later the author slips in places into hero worship. In chapters seven and eight Deffeyes explains how he uses a slightly modified version of the Hubbert model to make his own prediction that global maximum oil production will occur in about the year 2005. Not only does Deffeyes forecast the year of maximum production, he also forecasts some of the economic consequences. We will face an absolute shortfall as demand increasingly outstrips supply and the world's economy falters in a struggle for oil.

And what about the prerequisite assumptions for the model? Deffeyes doesn't seem to quite get the significance of substitution. He cites the symmetrical curve of historical Pennsylvania anthracite production as an example of a Hubbert-style depletion cycle. The decline in coal mining in Pennsylvania was unrelated to rising prices and probably resulted from the market's switch to cheaper, more convenient sources of energy. The second critical assumption in his version of the Hubbert model is that the amount of ultimately recoverable oil in the world is fixed at two trillion barrels. He offers this opinion of world oil without explanation or documentation, and he has no patience for those who might have a different view. He is particularly critical of the petroleum resource analysts at the USGS (with the exception of Hubbert, of course). The USGS recently published a new analysis of world petroleum resources exclusive of the U.S. that, when combined with an earlier 1995 U.S. assessment, identifies considerably more petroleum than does Deffeyes (about three trillion barrels of recoverable oil and natural gas liquids). He dismisses the results of the one-hundred man-year effort as "implausibly large" and condemns the USGS studies as the work of "bureaucrats." His case would be stronger if a scientific analysis of his assertions was included.

Throughout the chapters, he also directs various dismissive and derogatory remarks at resource economists. Why? Evidently because they don't see any market indicators of impending permanent shortages and thus don't support his views of the future. Deffeyes complains that, "None of our political leaders seem to be paying attention." What about the Cheney report and the new Bush energy policy calling for substitutions as part of the equation?

Of course one reason these dire forecasts have not been widely adopted as the basis for policy and investment decisions is that pessimistic projections of oil shortages are nothing new. Concerns about the end of the petroleum era have been expressed since the earliest days of oil development. In contrast to the bub-

bling optimism of the wildcat explorationists, respected characters in government, academia, and industry have confidently and regularly predicted the inevitable end of oil abundance. For example, in 1885, when the world's greatest oil producing province was the state of Pennsylvania, the Pennsylvania state geologist warned that U.S. oil production would only last a few decades. In 1920, the director of the USGS told Congress and the administration that the United States had exactly nine years and three months of oil production left. In 1972, the Club of Rome, the philosophical predecessor to Deffeyes, predicted oil and gas shortfalls would occur well before the beginning of the twenty-first century. And so on.

In adopting the Hubbert model of resource depletion, Deffeyes joins a small but vocal group of latter-day Hubbert aficionados and resource pessimists, led by Colin J. Campbell, who have been publishing Hubbert-style analyses and predicting imminent (but constantly retreating) oil shortages for the last ten or fifteen years. Of course, just because previous forecasts have been incorrect does not necessarily mean that peak oil production won't occur sometime in the future. Deffeyes would like you to join him in his belief that his forecast is the correct one.

If you are a lay reader interested in a non-technical introduction to the world of petroleum geology as it existed in the 1970s and 1980s, Deffeyes book might be a place to start. However, if you want to know about the global future of petroleum production or if you are looking for the scientific work on which to base an investment decision, be sure you get other opinions.

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GEOGRAPHY AND ENLIGHTENMENT. *David N. Livingstone and Charles W. J. Withers, eds. 1999. University of Chicago Press, Chicago and London. 455 p. Softcover, $25.00.*

The days when the mention of Enlightenment fostered thoughts of a relaxed read and a leisurely guide to the minds and mores of eighteenth-century *philosophes* are over. This dense and richly textured book derives from the papers presented at a conference in Edinburgh in 1996. Casual readers from the earth sciences, unfamiliar with contemporary criticism and thinking in the humanities and the social sciences, may be perplexed by the terminology and perspectives adopted. For example, the editors tell us that geography itself, for historians of geography, "is now understood more as a set of discursive situated practices and much less readily as a formal and unified academic discipline." Almost as the Enlightenment movement itself, in the broadest of broad brushes, might be viewed as a civilization coming of age and reflecting upon itself and where it might be headed, so in a sense is geography reinterpreting the distanced and densely documented "long eighteenth century" as a means of self-exploration in a landscape where disciplinary foci are blurred.

The book is organized into four groups of papers on beginnings, mappings, travelings, and placings, each section prefaced with a few pages. The very first chapter, standing outside these sections, gives the neophyte some broad guidance, but a geologist might prefer to tread more familiar ground with Roy Porter in his illuminating afterword. With this guidance the earth scientist can venture with profit into the contextual contours of chapters on mapmaking by Edney, Hum-

boldt's visual thinking by Godlewska, the critical reception of Humboldt's work on Mexico by Rupke, and the Lisbon earthquake by Gould.

Additional chapters by Carter on "Gaps in Knowledge . . . ," wherein Hutton and Playfair are touched upon, and by Outram "On being Perseus . . ." will inform the reader on more generalized issues. Of all these perhaps Outram's short chapter is the most interesting, with its emphasis on the feeling of exploration—"in learning to reconstruct the act of cognition through which the explorers came to know the world"; and concomitantly the meaning of transient fieldwork and instrumentation vis-à-vis the stay-at-home "sedentary naturalist" such as Cuvier. Outram details the ways in which developing techniques of instrumentation fell far short of becoming an objective substitute for the explorer in person, for all that in time they revealed regularities about the real world. There are still lessons to be learnt about the translation of knowledge about the real world—however it is acquired—into an interpretable form for humans, and for this reason Outram's short chapter is the most essential read for earth scientists and naturalists.

Overall the book will not provide the nitty-gritty of individual careers or disciplines with which to enhance or embellish one's chosen biography, but will inform on the new modes of thought within which future interpretations of history will be placed. It makes for hard and at times rather unproductive reading. Nevertheless it defines the changing nature of historical interpretation.

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MESOZOIC VERTEBRATE LIFE: NEW RESEARCH INSPIRED BY THE PALEONTOLOGY OF PHILIP J. CURRIE. *Darren H. Tanke and Kenneth Carpenter, eds., and Michael W. Skrepnick, art ed. 2001. Indiana University Press, Bloomington. 577 p. Hardcover, $49.95.*

It is quite common for researchers to celebrate the work of senior academics upon their formal retirement from official duties through the production of a *Festschrift.* This edited volume appears to be attempting to break new ground by offering a "celebration" volume for a scientist in mid-career. Philip Currie, though trained in Montreal (on non-dinosaurian reptiles), has spent the majority of his working career to date in Alberta working on dinosaurs. He has run a series of very successful field-parties and expeditions both locally and across the Americas and Asia. He has gained particular renown in recent years through his association with the discovery of feathered dinosaurs of China.

This weighty volume comprises thirty-three articles covering various themes within the general field of dinosaur paleontology and forms another in an apparently endless stream of what might be described as "dinoscience coffee-table/textbooks." The dust-jacket is adorned by the visually attractive but obligatory large and toothy predatory dinosaur looking for lunch. The jacket notes tell the reader that this "represent[s] cutting-edge research on dinosaurs and other vertebrates from an important period in the life of the past." The book is divided into seven sections: Theropods (carnivorous dinosaurs); Sauropods (the gigantic long-necked herbivores); Ornithischians (a variety of smaller herbivores); faunas; pathologies; footprint evidence; and finally, the rather memorably titled "Dinosaurs in human history." There is also an insert on heavier-grade paper that includes some color photographs of details of the Chinese dinosaurs that exhibit feathers or feather-like body coverings and various photographs of dinosaurian artwork.

As a vertebrate paleontologist I found a few of the papers presented here of interest, particularly where they highlight or describe new discoveries; to be quite frank, as an old cynic, I tend to expect a rather variable quality in the contributions to a *Festschrift*-style volume such as this. This books now joins quite a long line of recent edited volumes about dinosaurs. From a marketing perspective it seems clear that publishers such as Indiana University Press must have found a lucrative source of material with (presumably) sales to match. I truly have no idea who buys these books. On the one hand they clearly look like popular, coffee-table-style books, judged by the cover and color section. Yet internally they are simply clusters of largely impenetrable scientific papers. Even the discrete sections into which the book is broken lack some sort of introductory section or an "overview" that might help to leaven the mix a little.

As a reviewer I am clearly missing something fundamental here. I suffer a personal dilemma: as a scientist I really do need access to volumes like this because of just a few of the contained papers, but I don't really feel that I need to buy the whole book. I am not sure what a more general reader gets out of this at all—unless it is the vicarious thrill of being in touch with "real" dinosaur research because of an interest heightened by the "Jurassic Park" industry.

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RIVERS IN TIME: THE SEARCH FOR CLUES TO EARTH'S MASS EXTINCTIONS. *Peter D. Ward. 2000. Columbia University Press. 315 p. Hardcover, $29.95*

With *Rivers in Time,* Peter Ward has penned an account of three of the major extinctions in the history of life on Earth (at the Permian/Triassic, the Triassic/Jurassic, and the Cretaceous/Tertiary boundaries) in the context of understanding the current biodiversity crisis as a modern mass extinction. Ward generally has a fluid writing style and incorporates personal anecdotes with factual material, providing a nice balance of fact and theory. By weaving information on each extinction event into the context of his own personal visits to outcrops, museums, conferences, and fieldwork around the world, he has made the text nearly autobiographical. In doing so, he conveys the excitement of paleontology as not simply the search for the next species of dinosaur, but also as the desire to answer fundamental questions underlying the evolution of life on Earth.

The permanence of species extinction and the evidence that species loss in the deep past has led to massive ecosystem collapse, with consequences that we do not yet understand, is used to drive home the necessity of preserving and protecting at least some parts of our planet from human impact. In particular, Ward does a nice job of presenting scientific research as a dynamic process, giving the reader an idea of what we knew ten years ago, what we know now, and what we hope to learn through future research. The book includes generally sound and comprehensible explanations of the relevant stratigraphy, taphonomy, and the invertebrate fossil records, although the plant fossil record is neglected and in some instances the reader is left with the impression that terrestrial vegetation has changed little throughout the Phanerozoic. Scattered through the book are an interesting series of black-and-white photographs of outcrops, vistas, people, and organisms relevant to the text. A short list of relevant references for each chapter is provided at the end of the book for the reader interested in pursuing the topic further.

Ward can be a bit overly sensational in his prose, and some of his reports are a bit slanted with regard to the personalities involved. All of this is understandable because Ward has spent his career in the middle of this particular scientific fray. The text includes gossipy nuggets about dead paleontologists, such as the story of how, in 1913, South African paleontologist Robert Brown sold a large portion of the South African collection of key vertebrate fossils from the Permian Karoo Basin to the American Museum of Natural History (where they apparently remain) for "a sum large enough to make him financially secure for life." *Rivers in Time* is not meant to be a hardcore, scientific text nor a highly annotated, historical account of the science behind our understanding of a mass extinction. But it does provide good doses of both scientific information and history of science and still manages to be a good read.

Give this book to someone who knows little about paleontology but has always been interested, or to the undergraduate wavering on the decision of whether a career in research science is worth going through five years of graduate school. For all the book's flaws, Ward has done a powerful job of conveying the excitement of scientific research and a fundamental appreciation for the need to protect the biodiversity of the natural world.

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TSUNAMI: THE UNDERRATED HAZARD. *Edward Bryant. 2001. Cambridge University Press, Cambridge, U.K. 320 p. Hardcover, $74.95; Softcover, $27.95.*

The book *Tsunami: The Underrated Hazard* by Edward Bryant presents a well-written overview of tsunami origin and dynamics (the word tsunami is both singular and plural in Japanese). Throughout the book, many historical tsunami events are described, shedding light on how tsunami have affected human culture and how the science of tsunami has evolved. Professor Bryant, a process geomorphologist by specialty, is head of the School of Geosciences at the University of Wollongong, Australia. As might be expected, there is slightly more emphasis on coastal geomorphology and southeastern Pacific tsunami than in the few other books written on tsunami. What distinguishes this book from previous efforts is that it describes at length tsunami caused by landslides, volcanic processes, comets, and meteors. Although the author indicates that non-earthquake sources generate only 17.7% of the world's tsunami (and 15.5% of the casualties) over the last two thousand years (p. 21), emphasis on these unusual sources of tsunami reflects a recent trend in tsunami research to study all possible tsunami origins. This modern trend, instigated largely by the anomalous 1998 Papua New Guinea tsunami that killed over 2,200 people, is a response by the tsunami community to attempt to gain a comprehensive knowledge of a natural phenomenon that has historically occurred in unusual places and in unusual ways.

The book is divided into four main parts: I. Tsunami as Known Hazards; II. Tsunami-Formed Landscapes; III. Causes of Tsunami; and IV. Modern Risk of Tsunami. Part I includes a concise discussion on tsunami dynamics—much of which is necessary to understand tsunami warning systems and the effects of tsunami on coastlines. In Part II, Tsunami-Formed Landscapes, Professor Bryant demonstrates his expertise by detailing erosional and depositional signatures left by tsunami. This section will appeal to many readers with a geological background. The pen-and-ink scientific drawings of geologic processes in this section, as well as the artwork used throughout the book, greatly aid in understanding the

dynamics of tsunami—one of the few natural phenomena not extensively captured by modern video.

Part III is the largest part of the book (130 pages) in which the four main causes of tsunami (earthquakes, landslides, volcanic movements, and comets and meteorites) are examined. Each of these four sections begins with a theoretical description of tsunami generation, followed by several well-researched historical examples. Scientific details and assumptions are frequently glossed over; however, the author provides key references at the beginning of each section for those readers wanting more technical information. Because only a few historical landslide and volcanogenic tsunami are known (e.g., Lituya Bay in 1958 and Krakatau in 1883, respectively), Bryant also provides examples of tsunami inferred from the geologic record (e.g., the Nuuanu slide north of Oahu, Hawaii, approximately 200,000 years ago). With much hype in the popular media about "mega-tsunami," Bryant's section on comets and meteorites presents a refreshingly objective review of recent scientific investigations. This section concludes with a detour to legends and myths attributed to impact events.

Building upon a solid background of tsunami physics, Part IV of the book concludes with a discussion of the present-day tsunami warning system and possible future improvements. As incumbent upon any author of a book on tsunami, this section also includes important advice on how the reader should respond to a tsunami warning. One should not be among those that "flock to the coast to see such a rare event" as was the case in San Francisco following the Great Alaska earthquake and tsunami of 1964 (p. 286). The result of this type of societal impulse can be and has been devastating.

Arguably, the most intriguing parts of the book are two series of short stories or vignettes at the beginning and end of the book. In the introduction, five historical stories are presented and the reader is asked to distinguish legends from "scientific fact." The author's insightful description of the origin of the stories demonstrates that some legends can be corroborated by modern scientific evidence. In the epilogue, five hypothetical stories are presented (strikingly similar to the historical stories in the introduction) for the purpose of conveying the unpredictable nature of tsunami. At this point, the boundaries between fact, legend, and science fiction start to blur—as does the intended audience of the book.

Implicit within these stories is the fact that our knowledge of tsunami depends, at least in part, upon eyewitness observation. Certainly, for most modern tsunami events and many historical events, there are tide-gauge records of the waveform and waterline marks indicating run-up. However, because of the chaotic nature of tsunami dynamics, sparse and infrequent instrumental observations are often supplemented by eyewitness reports to infer the severity of past events. It is the objective nature of these reports then that falls under question. For ancient cultures, natural or mythological symbols were often used to assign meaning to a phenomenon that had previously been unimaginable, as described in the "Comets and Meteorites" section. Bryant also argues in the introduction that modern events that rely heavily on eyewitness observations such as the 1998 Papua New Guinea tsunami will "represent the early phases of an oral tradition or folklore." He continues: "When there are no witnesses to a notable event left alive and no written records, then all these stories become legends. Legends have an element of truth, but often the exact circumstances of the story cannot be verified."

In twenty-first-century society, tsunami images such as Hokusai's ubiquitous woodcut "Great wave off Kanagawa" serve as symbols for fascination rather than for meaning. The exception is in places such as Japan where many people retain a personal experience of the destructive nature of tsunami. Outside regions where tsunami frequently occur, however, one may infer that fascination about tsunami leads to viewing tsunami as an "other-world" phenomenon and agree

with Bryant's general premise that tsunami are an "underrated hazard." Bryant's hypothetical stories in the epilogue, as well as his overall emphasis of unusual tsunami sources, serve to disrupt one's sense that tsunami are predictable phenomena. This perspective, however, needs to be balanced with the overall likelihood of occurrence for unusual tsunami. Given finite resources, regional tsunami warning systems are designed for tsunami with the highest likelihood: namely, seismogenic sources within the Pacific Basin. Regional warning systems are continually improved as new technology is developed and as new potential tsunami sources are discovered, particularly landslide and volcanogenic sources. Thus, tsunami hazard mitigation efforts do not necessarily "underrate" any particular tsunami source. Rather, decisions are made based on available resources and likelihood of occurrence, the latter of which evolves alongside our scientific understanding of tsunami.

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LES AGES DE LA TERRE. *Francois Frohlich and Henri-Jean Schubnel, eds. 2000. C.T.H.S., 1, rue Descartes, 75231 Paris cedex 5. 120 p. Softcover, 22.87 Euros + 3 Euros shipping*

The Comité des Travaux Historiques et Scientifiques (C.T.H.S.), in cooperation with the Museum National d'Histoire Naturelle of Paris, produced this volume of 24 short papers for the museum's exhibition, titled "The Ages of the Earth," in 1999. The exhibition was dedicated to the memory of George Louis Leclerc, Comte de Buffon (1707–1788), and the first paper, "Quelques ages de la Terre: de Buffon a Rutherford" (Some ages of the Earth: from Buffon to Rutherford), by Henri-Jean Schubnel, outlines the development of scientific ideas on the Earth's age. Given the rich history of the development of the earth sciences in France, it is good to see this historical paper placed first in the volume.

The other twenty-three papers present to the reader a basic geology course, with an emphasis on the geology of Western Europe. The "course" starts from the origin of the Earth ("L'Hadeen ou le débuts de la Terre" by Jean-Pierre Lorand, Louis Latouche, and Michel Guiraud). Subjects may be as large as the origin of life ("L'origine de la vie," by Florence Raulin-Cerceau) or as small as diatoms ("Ce que nous recontent les diatomées," by Aïcha Gendron-Badou). The final paper deals with the present industrial era and the understanding of our geological inheritance ("Le Quaternaire recent ou l'ere industrielle: Plaidoyer pour la prise de conscience de l'existenece d'un patrimonie geologique," by Pierre-Jacques Chiappero).

Although historical figures (e.g., Darwin, Brongniart, de Charpentier, and Louis Agassiz) are mentioned in some of the papers, there are no lists of references in any paper. Therefore this is not a work to be consulted as a primary source for either scientific or historic studies. It is, however, certainly one of the most beautiful exhibition companion volumes I've ever seen. The illustrations are perfectly drawn and reproduced. The color photography is magnificent, from the cover photos of the volcano Stromboli to the gorgeous minerals featured in the short paper "L'age des mineraux," by Schubnel.

In short, *Les Ages de la Terre* is a wonderful document of an historic museum exhibition.

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