

BOOK REVIEWS

PARRISH, J. T. 1999. *Interpreting Pre-Quaternary Climate from the Geologic Record*. Perspectives in Paleobiology and Earth History Series. xv + 338 pp. New York: Columbia University Press. Price US \$65.00 (hard covers). ISBN 0 231 10206 2.

In the last quarter century, great advances in Quaternary palaeoclimatology that began with the CLIMAP project, the copious results of the Ocean Drilling Programme, new high-resolution geochronological and geochemical methods and a blossoming of palaeontology/palaeobiology, have greatly intensified our interest in and understanding of the surface history of the Earth. The lively integration of historical geology, stratigraphy and palaeontology that makes this a new revolution in the earth sciences, a 'quiet revolution' as Nick Shackleton has labelled it, admittedly resting on the realistic palaeogeography supplied by its predecessor, the plate tectonics revolution, but a revolution none the less that is fuelled by palaeoclimatology and palaeoceanography.

In this revolution, the climatic and on a lesser scale stratigraphic modelling approaches introduced in the 1970s are playing an ever more dominant role, and have begun to take on to a worrisome degree a life of their own where the models of one modeller become the 'data' of the more sophisticated models of another modeller. Some of these efforts have proved helpful where they attempted to set limits for suggested causes, such as those that have attempted to assess the poleward heat flux needed to explain an ice-free Earth. Others, especially when modelling the continental climate without taking the oceanic heat transport into account, have been of little help. Stratigraphic models depict continental margin sedimentation in ever greater numbers, but studies of their real sedimentary sequences have, with exceptions, gently slipped into the background.

Judith Parrish's book is an attempt, here and there a slightly belligerent attempt, to restore the balance between studies of the surface of the Earth and its history as it can be read from the record of the rocks and the flood of models that place the burden of proving their validity on other geologists. Sometimes, in fact, they seem to be partly inspired by the realization that getting lithological and palaeontological data is hard and time-consuming work that may yield ambiguous results, whereas modelling is quick and produces maps and sections in glowing colours that seem most convincing.

To someone like myself who has been worrying more and more about the increasing schizophrenia in the Earth sciences where Earth processes, deep, shallow and surficial, have taken over much of our teaching at the same time that the theory embodied in modelling has taken over the historical aspects, Parrish's book is a breath of fresh air, a stimulus to renovate and reinstate the teaching of Earth history as at least half and, I would argue, probably the ultimate half of what Earth science is all about. It undertakes this task in a modern and thoroughly interdisciplinary spirit.

Parrish's book is a monumental undertaking, even though it is focused predominantly on the study of ancient climates, but other aspects of the palaeo-environment do creep in through the mesh here and there. Its foundations are sedimentology and sedimentary geochemistry together with

palaeobiology (in the broadest sense of that term), a subject that itself is undergoing a period of rapid growth in depth and breadth. This is a rich and diverse field that she harvests and it is not surprising and surely forgivable that, constantly forced to sort and select what views she should give prominence to, she not infrequently ends up in the hot water of controversy. The book is very new in what it tries to do, brings together a vast up-to-date literature and crosses several disciplinary boundaries, making accusations of error and even incompetence tempting and unavoidable.

The book is far more than a mere description of sedimentary indicators of facies and of fossils as tracers of environment. A great deal of work has been done since this reviewer acquired the right to call himself a sedimentologist, but unfortunately recent debates have seen few inspired syntheses of the meaning of sediments and their fossil content. Well, here is a strong and in the main successful attempt. The contents, after a brief introduction of principles, are organized into four categories, marine biotic (including a good deal of geochemistry) indicators, marine lithological indicators, and their terrestrial and freshwater biotic and lithological counterparts. Over the last decade or so, my own interests have been close to this subject, but I have none the less found here a great deal that was new to me and much more than in this synthesis was exciting.

The weakest and surprisingly small part of the work is the final chapter on palaeoclimate models and data-model comparisons. What there is contains some useful but rarely stated truths about climatic modelling as applied to the pre-Quaternary, truths which the author spells out without bothering to be sweet about it and evidently regarding them much as mere fashion and not likely to live long. Of that, I believe, we could have used some more here. Not surprisingly, it is this part that has drawn the ill-concealed ire of some of the younger generation of modellers that is visible in some reviews. It is too bad; to fail to see a gold mine right in front of you out of principle is sad and not very clever.

In short, here is a substantial part of what we need to think about, learn about in order to appreciate the new stratigraphy and historical geology, including the rich material that we must teach to our students. The book is not cheap, but perhaps a positive response by us will persuade the publisher of a fact that Henry Ford already knew: it is more profitable to sell many cheap cars than a few luxury ones. The least you should do is to get your library to buy a few copies and then make your students read them.

Tjeerd H. van Andel

KNIGHT, P. G. 1999. *Glaciers*. xxv + 402 pp. Cheltenham: Stanley Thornes. Price £27.50 (paperback). ISBN 0 7487 4000 7.

With *Glaciers*, Peter Knight treads bravely into the increasingly competitive world of glaciological text books. For *Glaciers* to be a success it must equal or better Benn & Evans' excellent *Glaciers and Glaciation* (Arnold), Bennett & Glasser's well-produced and accessible *Glacial Geology* (Wiley), and Paterson's ever reliable and high-quality *The Physics of Glaciers* (3rd ed., Pergamon), not to mention numerous other decent, more specialized texts. It is not sim-

ply the intensity and quality of the competition, however, that I feel will restrict the general appeal of *Glaciers*. While the text is hugely informative, it suffers from a number of important shortcomings. For example, even though the book is well written and easy to read, commonly developing themes in a personal style from general principles to detailed cases, its progressive style makes it difficult for readers to dip into as a reference source. The layout of the book is traditional and, it has to be said, rather bland. It must also be mentioned at the outset that, despite topics being well exemplified and referenced, the illustrations are woeful: the quality of Figures 1.1 to 1.3 sets the scene for the remainder of the book.

The book has 12 chapters, designed to be read sequentially. The two introductory chapters ('Introduction' and 'Glaciers and the Global System') are easy to read and provide adequate background to our current understanding of glaciers. This is followed, like most of the standard glaciological texts, by a chapter on the 'Formation and Mass Balance of Glaciers' (Chapter 3). Chapters 4 and 5 respectively cover 'Material, Chemical and Thermal Properties of Glaciers' and 'Structure and Morphology of Glaciers'. Chapter 5 is particularly interesting, most closely reflecting the author's own research interests, particularly in the character and formation of the basal ice layer. 'Glacier Hydrology' is addressed in Chapter 6, bringing the reader up to date on most aspects of glacier damage, from the generation of meltwater at the glacier surface to methods of investigating the structure of subglacial drainage systems and flow pathways. As with many of the topics covered in the book, this chapter is well referenced and refers to numerous case studies. The section concerned with glacier floods, or jökulhlaups, is particularly informative, developing the theme, as the author does throughout, with reference to several examples. Glacier motion is addressed in Chapter 7 (Movement of Glaciers), where the reader will find an authoritative and broad review of the processes of glacier motion and their controls. The chapter also provides useful sections on ice streams and surge-type glaciers. However, this chapter does suffer from a series of (unnumbered) equations that are presented without units or explicit referencing. Such referencing may be crucial where a reader wishes to pursue a particular problem or line of investigation further. At least one equation (that describing basal sliding velocity by regelation on p. 130) also contains a significant error. Chapter 8, entitled 'Glacial Fluctuations', is short and interesting, focusing, through several case studies, on the causes, time-scales and mechanisms of changes in glacier morphology. The chapter might well have sat more comfortably immediately following Chapter 3 (Formation and Mass Balance of Glaciers), which it closely follows in terms of the development of ideas. Chapter 9 deals capably with 'Glacial Sediment Transfer and Geomorphology', adopting a strongly geomorphological perspective on glacial processes (sediment erosion, transport and deposition) in a variety of glacial environments (subglacial, ice-marginal and proglacial). Chapter 10 summarizes and adds to our knowledge of 'Glacier Hazards and Resources', although, by its very nature, this chapter presents little more than a series of death counts and interesting, aborted projects. The latter includes iceberg towing projects and, most notably, a British scheme considered during the Second World War to construct aircraft carriers from a mixture of ice and wood pulp. Chapter 11, which deals with the important topic of 'Ice Cores', provides a relatively brief overview of core acquisition programmes and the potential uses of ice cores. Here, however, I would have preferred to have seen a far deeper

review of the significant environmental and glaciological advances that have been achieved through a number of recent, high-profile coring programmes. Such a review would be timely and useful; perhaps an opportunity missed. *Glaciers* ends with a chapter on 'Research Directions in Glaciology', charting the history of glaciological investigations and technology (perhaps better located in the Introduction) and a brave final section on the future of glaciology.

If read cover-to-cover or chapter-by-chapter, *Glaciers* will leave the reader with a firm and broad understanding of the formation, structure and behaviour of glaciers. As a glaciologist, I find the strengths of this book lie in its explicit focus on glaciology, and in its easy and personal narrative style. However, it is precisely these features that may reduce the appeal of the text to others: the focus on glaciology prevents broader discussion of, for example, Quaternary history and glacial geology, while the book is not laid out in a modern, student-friendly manner. Any book about glaciers should also contain exciting, high-quality photographs; unfortunately, *Glaciers* does not.

Bryn Hubbard

RYAN, W. & PITMAN, W. 1998. *Noah's Flood. The New Scientific Discoveries about the Event that Changed History*. 319 pp. New York: Simon & Schuster. Price £17.99 (hard covers). ISBN 0 684 81052 2.

The story of a universal flood near the beginning of human history is deeply ingrained in the memories of many cultures. The best-known is probably the flood at the time of Noah recorded in the Bible: this book takes its title from that flood. But other traditions, such as the Gilgamesh epic from Mesopotamia, which was transmitted orally for maybe as long as 2000 years, before being recorded in cuneiform writing, and the even older but now fragmentary Sumerian version of the flood called 'The Deluge', may well record the same event.

Although geological evidence does not support the occurrence of a truly global flood, most commentators have hitherto considered the most likely scenario to be that the flood occurred across a tract of the so-called fertile crescent of Mesopotamia. This region is known to have been relatively densely populated from the time of the end of the last major ice age some 11 000 years ago, with early examples of humans living in settled villages and beginning to cultivate cereals. It suffered numerous locally devastating and unpredictable floods of the Tigris and Euphrates rivers, caused mainly by spring-time snow melt in the Taurus Mountains. But, as Ryan & Pitman point out in this book, such river floods are but temporary and localized affairs, and people could usually move back to their land within weeks if not days; they also occur rather suddenly and without the long prior warning that is a strong feature of both the Gilgamesh epic and the biblical accounts of the flood.

Ryan & Pitman put forward the alternative hypothesis that the flood occurred when the Black Sea basin, a fertile and quite probably inhabited area around a fresh-water-lake some 400 feet below sea level, was inundated through the Bosphorus by rising sea levels when there was widespread melting of ice caps at the end of the final burst of the Ice Age some 7500 years ago. This idea developed from the now well-known and even more astonishing flooding of the Mediterranean Basin that occurred about five million years ago. During the Messinian, for a period of perhaps two million years, movement of the Spanish block against North Africa had closed the marine connection between the

Atlantic Ocean and the Mediterranean Basin. As a result the Mediterranean largely dried up, leaving thick salt deposits on its floor. Continuing plate tectonic movements eventually opened the Straits of Gibraltar, and the resulting flood which refilled the Mediterranean with seawater scoured deep channels down its sides. This happened five million years ago, well before any humans were on the scene. But maybe, mused Ryan & Pitman, spurred on by the British geologist John Dewey, a similar thing may have happened in the Black Sea when early humans were around to experience it.

There is little doubt that the Black Sea basin indeed underwent episodes of isolation from the Mediterranean Sea, when the water level would have dropped substantially and it would have become a fresh-water lake, until rising sea levels again flooded it with seawater through the narrow Bosphorus channel. Ryan & Pitman discuss some of the early oceanographic expeditions to the Black Sea which established these changes. Whether humans were indeed living by the shores of the lowered and fresh-water Black Sea lake some eight millennia ago, and whether they were forced out by an inundation of such ferocity that it left an indelible mark on early human literature, is much more conjectural. It is, however, highly plausible.

The book explores this hypothesis entertainingly and with many vignettes and anecdotes drawn from the authors' own experiences. It is wide-ranging in its approach. Topics discussed range from early oceanographic expeditions to the Black Sea before the Cold War finally ended, through archaeological evidence for how and where peoples lived and migrated, to linguistic investigations of the way in which stories can be passed on orally through numerous generations.

The style of writing is rather flowery but, provided you are not in a hurry to extract the facts, it is easy reading. An example of Ryan & Pitman's description of the breaching of the Bosphorus is that the water flowed through as 'a thundering flume twisting and churning with rubble as it cleaved at the soft rock walls that now and then collapsed'. For any people who may have been living on the floor of the Black Sea basin, the flood would have been gradual, though relentless, rather than overwhelmingly sudden. Ryan & Pitman estimate that it would have taken perhaps two years to raise the water level of the Black Sea lake the 400 feet or so required to match the sea level in the Mediterranean: that is a rate of rise in level of about 6 inches per day. Nevertheless, they invite us to consider that 'It is hard to imagine the terror of those farmers, forced from their fields by an event they could not understand, a force of such incredible violence that it was as if the collected fury of the gods was being hurled at them'.

Is it plausible that this was the origin of the flood stories? Certainly so, in my opinion. Can it be proved? Not at present, though it is entirely possible and likely that new evidence will be adduced in the future that could test this hypothesis. Tighter and better dating of the ages of key events, both of the oceanographic changes in the Black Sea and of the archaeological remains and migrations of large bodies of people in the surrounding regions, is one obvious area. And it is certainly possible that detailed exploration of the Black Sea floor could reveal clues about the climate and maybe even of human settlement 7000 to 8000 years ago. I, for one, hope that the possibilities raised by Ryan & Pitman in this book are taken seriously and explored further. At a time when mankind is busy reaching for the stars, it is equally important to look back to our roots and to the events that shaped our destiny.

Robert S. White

VAN ROSE, S. & MUSSON, R. 1997. *Earthquakes. Our Trembling Planet*. 72 pp. Keyworth: British Geological Survey. Price £6.50 (paperback). ISBN 0 852722 87 7.

Although aimed at Key Stage 4 and A-level students, this excellent booklet would easily provide a good start for any first-year earth science undergraduate. Particularly useful is the artwork, with cutaway and coloured block diagrams illustrating plate boundaries and the propagation of earthquake waves. It can be very difficult to make these convincing as few illustrators seem to have the right appreciation of earth sciences, but Gary Hincks has generally done a good job here. One of the benefits of the plethora of high-quality children's books, such as those produced by Dorling Kindersley, is that standards of illustration have improved enormously in the last few years.

Starting with some case histories, such as the Lisbon quake of 1755, the text develops from faulting through seismology, plate boundary movements to surface effects, prediction and preparation. A short index list of books for further reading and, most usefully these days, internet resources completes the book. Well-informed texts like this are invaluable educational aids and hopefully our major earth science organizations like BGS will continue to produce books of this quality.

Douglas Palmer

BOLT, B. 1999. *Earthquakes*, 4th ed. xiv + 366 pp. New York: W. H. Freeman & Co.; distributed in the UK by Macmillan. Price £16.95 (paperback). ISBN 0 7167 3396 X.

This is the fourth edition of a popular book that was first published in 1978. As with earlier editions, this one has been updated with accounts of more recent earthquakes, the content has been re-arranged internally and some discussion of new developments has been included. This edition now contains a chapter on plate tectonics and a list of useful World Wide Web sites. The overall result is an easily readable account of what earthquakes are, where they occur, what happens in them, and what seismologists and earthquake engineers do. The text is mostly built around case histories, and many readers will enjoy knowing what lay behind the spectacular images of disaster that they will remember from television or newspapers. There are abundant photographs and well-chosen diagrams. The discussion is somewhere near the *New Scientist* level: no scary mathematics, but with enough numbers to be authoritative. The book will be an enjoyable read for any curious non-specialist, and interesting background (though probably too wordy) for an undergraduate in geology or geophysics.

To the professional, the book will seem curiously old-fashioned, most confident when addressing aspects of earthquakes that have been understood for 30 years or more. In me it provoked a comparison with Richter's great book *Elementary Seismology*, published in 1958 when plate tectonics was unknown, not everyone accepted that earthquakes occurred on faults, and many standard seismological tricks were controversial. Bolt addresses much of the same material and uses case studies in the same effective way, but has the enormous advantage that he can cut like a knife through the baggage Richter was forced to address. The result seems to me like a slim-line, lighter version of Richter's work, and very useful it is in that respect. However, it is not a 'state-of-the-art' account of seismology in any way

other than in its choice of up-to-date examples. There is passing acknowledgement of technical advances such as GPS, SAR interferometry and the proliferation of modern digital instruments, but little explanation of how they work or what they can do. It is a shame there is no indication of what earthquake seismologists, geologists or engineers are currently thinking about or aspiring to do, of how influential knowledge of earthquake faulting has been in structural geology, or of the quiet but astonishing success of the engineers, particularly in base isolation. Although it seems churlish to complain about what a book leaves out, especially when what it includes is well done, I do think this book is a missed opportunity. With a little more effort it could convey some of the excitement of the modern subject and do for seismology today what Richter's book did in the late 1950s.

James Jackson

SAVAZZI, E. (ed.) 1999. *Functional Morphology of the Invertebrate Skeleton*. xi + 706 pp. Chichester, New York, Weinheim, Brisbane, Singapore, Toronto: John Wiley & Sons. Price £150.00 (hard covers). ISBN 0 471 97776 4.

Despite the dynamism of living organisms, and we may assume their fossil counterparts, the study of their functional morphology has had a curiously static feel, most notably with its formulaic inclusion of Seilacher's now famous triangle of constructional morphology (with its endpoints of phylogeny, construction, and function) and Rudwick's elegant, but perhaps rather fruitless, concept of the paradigm. Add this to spasmodic gesticulations of the anti-adaptationists, and their mantra, repeated to meaninglessness of spandrels, and it is perhaps not surprising that the study of functional morphology is a bit like a ship becalmed: obviously afloat, the crew industrious, but where exactly is it going? In principle, therefore, we should welcome this volume, comprising as it does some 43 chapters (of which nine are written by the editor) that emphasize (reasonably enough) the molluscs (13 chapters), brachiopods and arthropods (six chapters each), as well as flanking sections on more general precepts (12 chapters) and what are referred to as 'other phyla' (six chapters).

Some highlights there certainly are, but the overall impression is of a series highly competent, but somewhat disparate, reviews that oscillate between the opening sections of the *Treatises on Invertebrate Paleontology* and the successful *Paleobiology: A Synthesis* (now heading for a second edition). Matters are not helped by photographic plates that range from just acceptable to poor. What of the highlights? Savazzi's opening chapter provides a helpful introduction, including an interesting defence for the use of teleology – shunned by senior professors who as they flee the room tactfully shield the eyes of their more impressionable junior colleagues – on the simple but cogent grounds that it allows 'a remarkably concise formulation of hypotheses and explanations, especially when applied to machine-like analogues of organisms or parts of organisms' (p. 4). Other chapters that particularly caught my eye were absorbing accounts of structural colours (by A. R. Parker) and land-snails (by C. R. C. Paul). Many others provided serviceable reviews, but there was perhaps justification for some degree of amalgamation. Noticeably G. R. McGhee's four chapters, on aspects of brachiopod shell form, might have been rolled into a single offering (as indeed is the case with the echinoderms (by S. K. Donovan)). More importantly this book is dotted with references to important data relevant to the documentation of such topics as optimization and limitations,

yet despite the opening section a wider synthesis is only obtained by a steady ploughing through this thick volume. Good training, no doubt, but I wonder how many beginners will be inspired by such an approach? Still there is no doubt that any serious research worker or library will be anxious to obtain this volume, although given its price few in the first category will be so fortunate.

S. Conway Morris

WOOD, R. 1999. *Reef Evolution*. xi + 414 pp. Oxford, New York: Oxford University Press. Price £55.00 (hard covers), £22.50 (paperback). ISBN 0 19 854999 7; 0 19 857784 2 (pb).

There have been many books written on the subject of reefs. This one, by Rachel Wood, reflects many of the current concerns and advances in reef studies, as well as her own particular interests. Her approach is to analyse the history of reef development on the basis of the fundamental processes and environmental controls that have resulted in the highly complex reef communities of the present day. The book is divided into three parts, an introduction to reefs both ancient and modern, environmental controls, and evolutionary innovation.

The first part begins with a general introduction to reefs and the inevitable and thorny problem as to what is and is not to be included within the definition of a reef. She takes the broadest of views, including any discrete carbonate structure with topographic relief formed by *in situ* or bound organic components. However, the book is biased towards medium- to large-scale shallow-water structures that would qualify as reefs or bioherms in anybody's view. Wood sets out the philosophy behind her book and its organization in some detail at the end of Chapter 1, and this constitutes a very useful trailer for what is to come.

The main elements in Part I are first, the criteria for the recognition of reefs in the geological record and second, a review of the reef record from the earliest mid-Precambrian microbialite structures through to the sub-Recent reef bodies of the late Tertiary. Reef recognition briefly covers such aspects as morphology, community structure and reef fabric, sediments, early lithification, the effects of taphonomic bias on ancient reef ecology, and tectonic setting. The review of the record is a particularly useful summary, but strongly biased to the Palaeozoic (53 pages) as opposed to the post-Palaeozoic (20 pages). There is an emphasis on cavities and cryptic communities, sediment fills, cements and the microbial contribution to Palaeozoic build-ups, which reflect the author's interests and which are much less fully explored in most similar books. This chapter is elaborated with boxes, covering the attributes of the principal organic components, and case studies which describe particular reef structures as examples at each stratigraphic interval. The boxes are useful as they include recent information not available in most standard textbooks. However, the case studies, while interesting, tend to break the narrative flow. My personal preference is to have such material fully incorporated into the running text.

The mid section of the book is concerned with two broad aspects of environmental influence on reef development. The first chapter reviews the physicochemical controls on inorganic and skeletal carbonate production, the factors that govern the distribution of living reefs and the way these have varied in the geological record. Reefs appear to be robust to environmental change on geological and evolutionary timescales, whilst the constituent communities may be transient, constantly reacting to local and unpredictable environ-

mental change. However, she also notes how anthropogenic stress may be complicating and/or obscuring the response of modern reef communities to environmental change. Having raised the importance of disturbance on the structure and composition of living reef communities, the following chapter explores in detail the much more profound influence of mass extinctions on the evolution of reef communities. She emphasizes that the correlation between the extinction of reef biotas and the reappearance of reefs after mass extinctions is poorly correlated. Slow recovery of reefs is largely an illusion created by the absence of large skeletonized metazoans, whereas microbial disaster floras built reefs as soon as stable carbonate platforms were available to support them.

The final part, on evolutionary innovation, begins by investigating the adaptive success of sessile organisms, particularly in terms of clonality and modularization. She reviews trends in form and function in the major groups of reef-building metazoans, concluding with a case study on the ecological attributes of the modular habit in archaeocyaths. It is clear that a limited number of functional organizations have evolved again and again in the various groups contributing to reef formation. One major factor that has changed during the Phanerozoic is the dramatic rise of biological disturbance since the mid-Jurassic. A chapter is devoted to the response of reef biotas to the activities of predators capable of boring, gouging and scraping skeletal benthos. This is a particularly interesting section, concluding that most antipredatory traits had their origins in the Palaeozoic as responses to physical agents of partial mortality. A final chapter reviews the role of photosymbiosis and the problem of recognizing its presence in ancient biotas. She concludes that there is no conclusive evidence for photosymbiosis in reef-associated faunas before the Upper Triassic and thus that, contrary to a widely-held belief, photosymbiosis was not a necessary prerequisite for reef-building in the past.

The book is well produced and well illustrated. Photographs on the non-glossy paper are sometimes a little muddy, but are generally clear and well chosen. Line drawings are generally informative, with some nice ecological reconstructions which have the merit of appearing to be more realistic than many others I have seen. There are some irritating minor errors and inconsistencies in the text, such as the range of the Palaeozoic Tabulata, correctly given as Early Ordovician–Permian in Box 3.7 (p. 65), but recorded elsewhere as from the Botomian (p. 46) or Cambrian (Tab. 8.4, p. 345), extending into the ?Triassic (p. 232). However, this should not detract from the general message of the text, which is well written and supported by a useful glossary. This is an interesting and informative book which should be read by all those involved in the ever fascinating and continually evolving study of reefs and their biotas.

Colin Scrutton

SCARTH, A. 1997. *Savage Earth. The Book of the ITV Series*. 192 pp. London: Harper/Collins, in association with Granada Television. Price £16.99 (hard covers). ISBN 00 220106 2.

This is the book of a very successful Granada TV series. However, unlike so many 'also ran' texts, this one really can stand alone on its own merit. As the title suggests, the book has an element of the 'crash, bang, wallop' approach to plate tectonics, earthquakes and volcanoes. But that is only to be expected and not unreasonable in a popular science book. Fortunately, however, the text eschews hyperbole. Subjects like this do not need it; accurate observation and the facts

speak loudly enough for themselves. The text is instead packed with information as well as being interwoven with relevant anecdotes. These introduce a human dimension and take the form of a series of interviews with the survivors of these natural catastrophes.

Alwyn Scarth has the advantage of being a professional science writer, who also has a good academic track record behind him. Consequently, the text reads very well and can be recommended for first year university students in Earth Science. Scarth has been well served by his publisher who has spent 'serious money' on high-quality colour photos and design. Luckily, the latter is not too obtrusive, although I suspect the bottom line was still picture- and design-led rather than text-led. For more advanced students his previous book *Volcanoes* (published in 1994 by UCL Press) gives a more science-based introduction to this particular aspect of the 'savage Earth'.

Douglas Palmer

LAMB, S. & SINGTON, D. 1998. *Earth Story. The Shaping of Our World*. 240 pp. London: British Broadcasting Corporation Books. Price £19.99 (hard covers). ISBN 0 563 38799 8.

Earth Story is the book of the successful BBC documentary series of the same name. Both have contributed significantly to high-quality popularization of Earth Science, mainly because of the major role played by Simon Lamb of the Department of Earth Sciences in Oxford in the production of the series and writing the book. His 'academic' presence provides a 'quality control' which can often be missing in popular books and documentaries.

The series also benefitted from contributions by other academic geologists who were well able to put over their enthusiasm and expertise without dumbing down the content. I am glad to find that some of them find their way into the book as well. Maarten de Wit (ex-Trinity College Dublin and Cambridge University) was particularly effective in demonstrating the wonderful geology of the Barberton Greenstone Belt in southern Africa.

The main focus of the book is on the major geological processes and features of the Earth, particularly those associated with plate tectonics. A significant problem for anyone producing a popular illustrated book of this kind on Earth Science is the provision of high-quality and accurate artwork. It can be very difficult successfully to picture major geological features and processes such as spreading ridges, subduction zones, magmatism, metamorphism. Even the really successful illustration of different kinds of faults can be remarkably difficult. As far as I am aware, the only scientific training available to illustrators is in the fields of natural history, mechanical or biomedical illustration. So it is very unusual to find artists and illustrators who have any basic knowledge or feel for large-scale geology. Lamb & Sington are particularly lucky in having the services of illustrator Gary Hincks for their artwork which makes an important contribution to the usefulness of the book for first-year students and any other beginners in geology.

The combination of well written, accurate and up-to-date text plus eye-catching photos and artwork, short bibliography, glossary and index, make this an attractive popular introduction to Earth Science.

Douglas Palmer

KAHLKE, R.-D. 1999. *The History of the Origin, Evolution and Dispersal of the Late Pleistocene Mammuthus–Coelodonta Faunal Complex in Eurasia (Large*

Mammals). 219 pp. Hot Springs: The Mammoth Site of Hot Springs, South Dakota, Inc. Price US \$29.95 (paperback). ISBN 0 913062 04 9.

The last glacial was characterized by some of the most cold-adapted large mammals ever known. Eurasian glacial faunas were typified by the presence of the mammoth and the woolly rhinoceros which gave rise to the so-named *Mammuthus-Coelodonta* Faunal Complex. Kahlke's approach focuses on the origin of the various faunal elements that constituted this terminal cold stage. The essence of this book is to document the evolutionary history of the faunal complex and, in turn, to throw light on the ecological conditions that preceded the last glacial maximum in Eurasia. The first appearance and subsequent dispersal of selected large mammals is traced through the Early Pliocene up until the Late Pleistocene.

After a brief introduction the second chapter provides a group by group review of the origins, evolution and dispersal of various mammalian faunal elements characteristic of the *Mammuthus-Coelodonta* Faunal Complex. This chapter documents the occurrence in Eurasia of the larger Pleistocene mammals but does not provide much synthesis of the information. A series of Late Pleistocene species distribution maps are provided. Chapters Three and Four summarize the information in Chapter Two, one chapter emphasizing the geographic origins of the genera and species discussed, and the other focusing on their chronology. Useful summary tables of both the geographic and stratigraphic distributions of the earliest faunal evidence are provided. The subsequent chapters outline the various adaptations to cold conditions and fluctuating temperatures that occurred across the mammalian taxa during the Middle to Late Pleistocene. The ecology of many of the mammals that became more cold-tolerant through time is discussed, together with the development of a new ecosystem during this period that had no pre-Quaternary or modern analogue. The author emphasizes the powerful influence this novel ecosystem, the so-called steppe-tundra, had on the structure of the *Mammuthus-Coelodonta* Faunal Complex. Finally, he discusses the unique nature of the Eurasian glacial mammal associations relative to the corresponding faunas of the New World.

This is a comprehensive reference work which summarizes a lot of information especially in terms of palaeontological faunal records. However, although each of the chapters has its own theme, much of the content is repetitive. It would have helped if the chapter aims had been introduced at the beginning of the book to act as a guide to the reader. In a few places the text is difficult to follow, maybe because the book is an English translation from German. It is also worth noting that although the author deliberately concentrates on the origin of the faunal elements there is a conspicuous lack of reference to extinction events. On the whole the book provides a broad perspective on why these remarkable mammals were able to adjust to the ever-changing climate that typified the Pleistocene Age.

Eleanor Weston

FREY, M. & ROBINSON, D. (eds) 1998. *Low-Grade Metamorphism*. x + 313 pp. Oxford: Blackwell Science. Price £44.50 (hard covers). ISBN 0 632 04756 9.

The combination of title and editors prepared me for another review of low-grade metamorphism. Actually, it is 12 years since the last major review (Frey, 1987), so this one

is about due. Straight away let me say that this review is up to date, authoritative, and brims with enthusiasm for the topic.

The editors, Frey & Robinson, have invited various experts to contribute chapters on aspects of low-grade metamorphism, and they themselves have contributed to certain chapters. Chapter 1 (Robinson & Merriman) is a brief introduction defining what low-grade metamorphism is and is not. Chapter 2 (Merriman & Peacor) is an excellent up to the minute report on the progress made in studies of low-grade metamorphism in pelites over the last ten years. We now know what the physical characteristics of illite crystallinity are: crystallite size is the key. Serious researchers now require access to XRD, SEM, TEM, SAED, and AEM to distinguish between the effects of progressive increases in T and P , the effects of progressive strain and retrogression. Despite the progress made it is still a problem to estimate accurate T and P in low-grade metapelites.

Chapter 3 (Merriman & Frey) reviews the patterns of low-grade metamorphism in pelites: different patterns can now be recognized in collisional thrust and fold belts, accretionary prisms and extensional basins, high-strain zones and contact aureoles. Examples from around the World are discussed. Chapters 4 (Schiffman & Day), 5 (Robinson & Bevins), and 6 (Alt) cover metabasites: namely petrographic methods, patterns of regional metamorphism, and hydrothermal metamorphism in the ocean crust respectively.

Radiometric and fission-track dating is discussed in Chapter 7 (Clauer & Chaudhuri). The pitfalls of not separating the finest and purest phases for radiometric dating are emphasized: inherited material will give 'non-metamorphic' ages.

The last chapter (Sharp) is on the applications of stable isotope geochemistry (H, D, C, S). Examples of fluid-mineral-rock interactions in sedimentary, igneous (including oceanic) and metamorphic environments are discussed; methods of thermometry and effects of volatile loss are reviewed. It seems that stable isotope geochemistry still provides the most powerful tool for constraining the conditions of low-grade metamorphism. This book was probably commissioned too late for a discussion to be included on the effects of low-grade metamorphism on negative $\delta^{13}\text{C}$ excursions in carbonates and interpretations of climate change.

As the editors admit, to be truly comprehensive this book should have included chapters on fluid inclusions and organic maturation; however, these have been covered in another excellent book by Frey (1987). My main complaint is that there is no final synthesizing chapter that brings together the previous chapters. There is an awesome 40-page-long reference list and an extensive index. This is a book for the academic researcher specializing in low-grade metamorphism and for the post-graduate student wishing for an up to date introduction to the topic. Petroleum geoscientists will be interested in Chapter 2 as it will give them insight into processes of lithification in shales. This book might be all about low-grade metamorphism but it is all high-grade science and well worth the money.

Grahame Oliver

Reference

- FREY, M. (ed.) 1987. *Low Temperature Metamorphism*. Glasgow: Blackie & Son.
- FRATER, H. 1998. *Natural Disasters*. Multimedia program on CD-ROM for Macintosh and PC. Berlin, Heidelberg, New York, Barcelona, Budapest, Hong Kong, London, Milan, Paris, Singapore, Tokyo: Springer-Verlag. Price DM 98.85, Ös 623.00, SFr 78.00, £41.20, US \$54.95 (hard covers). ISBN 3 540 14609 1.

It may be the concluding year of the International Decade for Natural Disaster Reduction (IDNDR) but natural disasters have continued to devastate many parts of the world in 1999, with major earthquakes hitting Taiwan and Turkey, floods in Indochina, and hurricanes Floyd and Irene bruising parts of the Caribbean and USA. In the past four years, natural disasters have claimed more than 25 000 lives and cost of the order of \$1 billion per week. Because of the varied geophysical, meteorological and hydrological natural causes of disasters, the complexity of interactions between natural and human factors, and the orders of magnitude ranges in temporal and spatial scales over which natural disasters develop and occur, an interactive CD-ROM sounds like a promising way to present information on the topic. Unfortunately, this offering from Springer doesn't really harness the potential of the medium. Much of the material I would sooner have looked up in a book rather than navigate through the programme's file architecture, and the information that is provided is often contained in no more than a paragraph or two.

There are animations for various kinds of phenomenon – snow avalanches, volcanic eruptions, etc., but these are rather pedestrian. Better are the simulations included in video clips from the German Climate Research Centre, but the resolution on these is rather poor (the movies appear in small windows embedded within a static menu) and they would have been much more valuable with an interactive dimension. The closest the programme came to this was the ability to inundate western Europe by various amounts of eustatic sea-level rise (enhanced by the appearance of images of famous national monuments and landmarks that would be submerged).

The translation is generally accurate (the original version of this CD-ROM was published in German in 1997) though there are some anomalies (for example, stratovolcanoes are said to be 'fed by magma that is rich in silicic acid'). And there appear to be a few bugs (subliminal images appeared when they presumably should not have on following some of the menu options). There are several tables of statistics, including summaries of disasters in 1995–7 (supplied by Munich Reinsurance), and a click-able map of global disasters. The level is appropriate for high-school or, at a pinch, first year undergraduate students. A lot of work has gone into design of this product but without more genuinely interactive simulations, etc., I think one could learn more from a well-chosen textbook and a handful of web-sites.

System requirements: Monitor 640 × 480, 250 colours, CD-ROM drive (quad); Windows 3.x, Windows '95, 486/33 or higher, 8 Mb RAM, soundcard; Macintosh system 7 or higher, 68030/25 or higher, 8 Mb RAM.

Clive Oppenheimer

BRENCHLEY, P. J. & HARPER, D. A. T. 1998. *Palaeoecology: Ecosystems, Environments and Evolution*. xxv + 402 pp. London, Weinheim, New York, Tokyo, Melbourne, Madras: Chapman & Hall; distributed in the UK by Stanley Thornes. Price £30.00 (paperback). ISBN 0 412 43450 4.

A new palaeoecology textbook is a welcome event. Palaeoecology came of age with the publication of several palaeoecology texts in the early 1960s including that by Ager (1963). Since then there has been an explosion of palaeoecological studies and the time is ripe for a new modern treatment of the subject. The Brenchley & Harper volume principally considers palaeoecological 'themes', illustrated

mainly by line figures; some key topics are discussed within 'boxes'.

There are ten chapters. Chapter 1 is an investigation of the history of the biosphere. Here there are brief definitions and principles discussed, as well as aspects of global change. Each chapter has a series of summary points, further reading and references. Some of the discussion is rather thin. I do not like the reference to redrawn figures which are taken from 'second-hand' sources so that the originator is not even mentioned. For example, Figure 1.6 is based on original work of Berner and colleagues but he is not even mentioned in the further reading or references. Similarly Figure 10.14 is actually based upon a figure of Milner which was redrawn by Benton. Other figures (e.g. 5.22) have been claimed to be altered but clearly have not been, and reference sources are not given in the reference list.

Chapter 2 considers 'Environmental controls on biotic distribution'. This discussion is limited to marine invertebrates. Chapter 3 on 'Taphonomy' considers aspects of both pre- and post-burial of organisms. There is no discussion of the term biostratigraphy. There is a brief discussion of fossil lagerstätten, but considering the extensive interest in such deposits this treatment is very superficial. Terrestrial examples are rather lacking. The discussion of the preservation of plants is short and out-of-date with rather few references or illustrations. Chapter 4 is on adaptive morphology but again this deals only with animals. Chapter 5 concerns trace fossils and mainly concerns invertebrate animal traces although there is brief mention of vertebrate tracks and an even shorter mention of animal-plant interactions. There is no discussion of the interesting area of vertebrate-plant interactions.

Chapter 6 considers fossils as environmental indicators and Chapter 7 populations and communities. I would have liked to have seen a discussion of ecospace and a mention of the interesting work of Bambach. Chapter 8 discusses palaeobiogeography. There is a very out-of-date consideration of leaf shape, size (physiognomy) and temperature with no reference to the important work of Wolfe. Overall any reference to plants is superficial and without useful follow-up references.

Chapter 9 outlines evolutionary palaeoecology of the marine biosphere in 55 pages, yet Chapter 10 dedicates only 39 pages to fossil terrestrial ecosystems. Considering the current interest in such ecosystems, including the availability of a major volume on terrestrial ecosystems, this chapter is particularly disappointing. There is little discussion of Coal Measure terrestrial ecosystems or of the role of fire, for example.

My overall impression is that this volume falls rather short of my expectations, and to what extent it fulfils its goal of being an 'informative and accessible account for students taking specialist palaeoecology courses' or being 'a valuable reference source' is unclear.

Andrew C. Scott

Reference

AGER, D. V. 1963. *Principles of Palaeoecology*. New York: McGraw-Hill.

FORSYTH, I. H., HALL, I. H. S. & McMILLAN, A. A. 1996. *Geology of the Airdrie District. Memoir for 1:50 000 Geological Sheet 31W (Scotland)*. x + 94 pp. London: HMSO for the British Geological Survey. Price £37.50 (paperback). ISBN 0 11 884508 X.

KEY, R. M., CLARK, G. C., MAY, F., PHILLIPS, E. R., CHACKSFIELD, B. C. & PEACOCK, J. D. 1997. *Geology of*

the Glen Roy district. Memoir for 1:50 000 Geological Sheet 63W (Scotland). x + 127 pp. London: HMSO for the British Geological Survey. Price £35.00 (paperback). ISBN 0 11 884519 5.

MAY, F. & HIGHTON, A. J. 1997. *Geology of the Invermoriston district. Memoir for 1:50 000 Geological Sheet 73W (Scotland).* x + 77 pp. London: HMSO for the British Geological Survey. Price £30.00 (paperback). ISBN 0 11 884532 2.

HALL, I. H. S., BROWNE, M. A. E. & FORSYTH, I. H. 1997. *Geology of the Glasgow district. Memoir for 1:50 000 Geological Sheet 30E (Scotland).* x + 117 pp. London: HMSO for the British Geological Survey. Price £45.00 (paperback). ISBN 0 11 884534 9.

PATERSON, I. B., MCADAM, A. D. & MACPHERSON, K. A. T. 1998. *Geology of the Hamilton District. Memoir for 1:50 000 Geological Sheet 23W (Scotland).* viii + 94 pp. London: The Stationery Office for the British Geological Survey. Price £35.00 (paperback). ISBN 0 11 884533 0.

These five memoirs from the British Geological Survey were published between 1996 and 1998 and are concerned with two different areas of Scotland. Three of the memoirs deal with parts of the Glasgow area in the Midland Valley, and two deal with the central Great Glen area, further north. Each memoir describes the geology of half of one of the maps of the Scottish 1:50 000 Geological Map Series, and covers an area approximately 20 km east-to-west, and 30 km north-to-south.

The memoirs range in length from 77 to 127 pages, and in price from £35 to £45. They all provide important, original and systematic descriptive reviews of the geology of their areas.

One of the main first impressions made by these memoirs is the clarity and attractiveness of their format. A large page size (218 by 277 mm) provides a feeling of space for the text, and the drafting and reproduction of line drawings, black-and-white and colour photographs are beautifully crisp and attractive. In most of the memoirs, some maps and photographs are presented in a full range of colours, and there is also general use of black line drawings combined with a single brownish-red colour which greatly enhances the information content and readability of others of the maps and diagrams.

The three Midland Valley memoirs present up-to-date and original reviews of the Silurian, Devonian and Carboniferous stratigraphy, some of it based on commercial data. Special treatment is provided of the Clyde Plateau lavas and other igneous rocks, and the Quaternary deposits of each area are also surveyed systematically. Chapters on Economic Geology, Structure and Geophysics are reminders of earlier Survey formats, but provide neat and readily accessible summaries for books which will hopefully be available in public libraries in these highly populated areas.

The Great Glen memoirs are largely concerned with the stratigraphy, petrology and structural history of the metamorphic basement, which includes both Moine and Grampian material with associated igneous rocks. Both memoirs also contain reviews of new Survey work on the Devonian sediments that were partly synchronous with important phases of movement in the Great Glen Fault Zone. Independent chapters on Faulting, Quaternary, Economic Geology and Geophysics again provide useful and readily accessible surveys of much new material.

Peter Friend

GARCÍA-GARCÍA, F., CISNEROS, G., FERNÁNDEZ-EGUIARTE, A. & ÁLVAREZ, R. (eds) 1997. *Numerical Simulations in the Environmental and Earth Sciences.* Proceedings of the Second UNAM-CRAY Supercomputing Conference. xiv + 283 pp. Cambridge, New York, Port Chester, Melbourne, Sydney: Cambridge University Press. Price £45.00, US \$69.95 (hard covers). ISBN 0 521 58047 1.

The past decade has seen computer-based physical modelling become part of the mainstream of scientific endeavour. Environmental sciences modelling poses technical challenges through the vast computational resources required (e.g. general circulation models and weather forecast models with data assimilation schemes) and highly complex non-linearities which are well beyond the ability of numerical analysis to describe, categorize or theorize about.

This book contains 31 papers presented at a conference on Numerical Simulations in the Environmental and Earth Sciences held at the National Autonomous University of Mexico. I approached the book with the notion that, to be successful, it would have to illustrate the technical problems faced by modellers in a fairly concrete way through examples. The dangers were that it could end up being a numerics book on the one hand, or simply a disparate collection of papers on environmental modelling on the other hand. My conclusion is that although it contains many interesting papers, it has not really avoided the second danger.

The book is divided into four sections, on General Circulation Models and Global Change (11 papers), Dispersion and Mesoscale Modelling (11 papers), Geophysical Data Assimilation (7 papers) and Methods and Applications in Geophysics (4 papers). The section on GCMs has mainly papers containing descriptions of the use of GCMs to study regional climates.

The second section, on Dispersion and Mesoscale Modelling, has a more numerical flavour, with several papers addressing the demands placed by specific studies on numerical techniques. There is a paper on adaptive finite element techniques for modelling pollutant transport (Pepper & Carrington), and another with some nice visualizations of a cloud model (Vergara), with a description of a semi-Lagrangian/semi-implicit model.

The third section, on Data Assimilation, has several papers dealing with computational and methodological issues with, for example, a nice review of Kalman filtering and a discussion of problems in solving large-scale eigenvalue problems. The final section has a couple of papers dealing with issues of parallelization.

Otherwise the papers were descriptions of the scientific conclusions of numerical studies. Many of these papers were very interesting, but did not have any particular numerical flavour. If you have a problem and need to find examples of how other people have solved them, you might be lucky and find out about it in this book, but it is not really comprehensive enough to be a reliable route.

Richard C. A. Hindmarsh

LANDING, E. & JOHNSON, M. (eds) 1998. *Silurian Cycles. Linkages of Dynamic Stratigraphy with Atmospheric, Oceanic, and Tectonic Changes.* James Hall Centennial Volume. New York State Museum Bulletin no. 491. ix + 327 pp. New York: New York State Museum and New York State Education Department. Price US \$40.00 (paperback). ISBN 1 55557 206 5; ISSN 0278-3355.

The apparently cyclic nature of many sedimentary successions is an enduring focus of geological fascination. The driving forces for such cycles provide endless scope for debate, given the complex inter-relations of processes in the atmosphere, oceans, biosphere and lithosphere. For cyclicity to be properly investigated, however, the successions concerned need to be easily dated and correlated. Silurian biostratigraphy offers a dating potential unrivalled before the Mesozoic ammonites, and the Silurian System has therefore become a productive testing ground for cycles and their significance.

The *Silurian Cycles* volume comprises part of the proceedings of the second international symposium on the Silurian System, held in Rochester, New York, in August 1996. The quality of such a collection is often too dependent on which scientists attend the meeting and which then choose to submit papers. By good fortune and judgement, the editors of *Silurian Cycles* have achieved a satisfactory coverage of the field, making the volume a valuable addition to the Silurian literature. The papers fall into one of four themes: nine on the physical evidence for eustasy, five on faunal evidence, four on short-term cycles and three on isotope studies. There is an abundance of new data and interpretation. Highlights include the attempt to calibrate the magnitude of Silurian eustasy (Markes Johnson and others), the recognition of cycles from proximity trends in storm sediments (Gudveig Baarli) and the growing support for the oceanic event hypothesis of Lennert Jeppsson. Insufficiently detailed correlations between graptolitic basin successions and shelly shelfal facies continue to be a problem. There is a challenging sting in the tail of the volume, with the observation by Rachel Heath and colleagues that early Silurian sea level changes do not seem to be reflected in the C and O isotope data from the well-constrained Estonian successions.

Silurian workers worldwide will find *Silurian Cycles* a valuable and thought-provoking volume. However, the book is perhaps rather too firmly targetted at those already familiar with the Silurian System, with only a brief preface by Markes Johnson and Ed Landing. A more informative introduction to Silurian matters would have been helpful for those not already in the club, and would have attracted more of the readers that this volume deserves.

Nigel Woodcock

JONES, M. K., BRIGGS, D. E. G., EGLINGTON, G. & HAGELBERG, E. (eds) 1999. *Molecular Information and Prehistory*. Special issue of the *Philosophical Transactions of the Royal Society, Biological Sciences* **354**, no. 1379, pp. 1–159. London: the Royal Society. Price not stated (paperback). ISSN 0962-8436.

The promise of 'fossil' DNA has taken something of a battering in recent years. Despite all the hype and energy devoted to bringing *Jurassic Park* to life and claims of extraction and amplification of DNA from amber insects, it all fell on its face when no-one could replicate results. However, the timely Ancient Biomolecule Initiative funded by NERC over the last five years has helped enormously to reassess the potential longevity and preservation of a range of biomolecules, including DNA. This issue of the *Transactions* will mostly be of interest to archaeologists, with articles about organic materials such as human hair, blood and the remains of medieval cattle. Nevertheless, the work that is being done here will be significant for palaeontologists in the long run because this is where the analytical methodology is being sorted out. Also, the decay processes and products of biomolecules are being worked out, often

for the first time. There are important discussions about the molecular taphonomy of animal and plant cuticles (D. E. G. Briggs) and assessments of the preservation of key biomolecules in the fossil record (J. L. Bada, X. S. Wang & H. Hamilton) which do reach back further into palaeontological territory.

Clearly, all is not lost; despite the apparently rapid rates of *post-mortem* biomolecule degradation, high quality information, including DNA, can be retrieved from 'fossil' material. Cold climate, water-free sites help, such as the Ice Age conditions which preserve 50 000 year old mammoths. And according to the editors 'the case is not closed for much earlier DNA'. If only Michael Crichton had written a book entitled *Ice Age Park!*

Douglas Palmer

LENTZ, H. M., III. 1999. *The Volcano Registry. Names, Locations, Descriptions and Histories for Over 1500 Sites*. ix+190 pp. Jefferson, NC: McFarland Inc.; distributed in the UK by Shelwing Ltd, Folkestone, Kent CT20 2BH. Price £26.95 (hard covers). ISBN 0 7864 0732 8.

The Volcano Registry is, as its name suggests, an alphabetical register of the known volcanoes of the world. It clearly owes much of its content to the efforts of the Smithsonian Institution's Global Volcanism Program, in particular their directory and gazetteer *Volcanoes of the World*. (The casual reader might be forgiven for not gleaning this from the introduction and acknowledgements!) Where *The Volcano Registry* differs from *Volcanoes of the World* is that it is more obviously a handbook: each volcano entry summarizes, in a sentence or two, the essentials of the volcano's location, age and eruptive history. In a few cases, a little garnish is added – an etymological note, perhaps; or a description of a recent eruption, or notable fatalities.

For the hurried reader, seeking information at their fingertips, the handbook format perhaps conveys some advantage over that of the larger compendium. Of course, as every careful reader will know, the problem with re-compiling data is that transcription can introduce errors. A quick glance reveals a few: three of the Caribbean Soufrières have longitudes that would place them in West Africa; the five submarine 'Rumble' volcanoes of New Zealand are mistakenly identified as the volcanic centres of White Island; and the Ethiopian volcano Fantale is erroneously distinguished from its synonym, Fantale.

While the serious volcanophile, whether amateur or professional, might not be too distressed to receive a copy of *The Volcano Registry* for Christmas, they would probably wish instead to save up their cash for the next reprint of *Volcanoes of the World*. Or, perhaps, a modem and a web browser sufficiently advanced to access the Smithsonian's electronic directory. In the end, there is no substitute for detail and quality when it comes to information.

David Pyle

Reference

- SIMKIN, T. & SIEBERT, L. 1994. *Volcanoes of the World*. Tucson: Geoscience Press.
- COURTILLOT, V. 1999. *Evolutionary Catastrophes: The Science of Mass Extinction*. xiv + 173 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £14.95, US \$24.95 (hard covers). ISBN 0 521 58392 6.
- FRANKEL, C. 1999. *The End of the Dinosaurs: Chicxulub Crater and Mass Extinctions*. xii + 223 pp. Cambridge, New York, Melbourne: Cambridge University Press.

Price £17.95, US \$24.95 (hard covers). ISBN 0 521 47447 7.

Two more books on mass extinctions. Both are very well written, although the one by Charles Frankel shows a greater scientific fluency, albeit with his finger closer to the button marked 'Melodrama'. There are some fascinating parallels between these two books. As it happens both were originally published in France, with Vincent Courtillot's book very ably translated by Joe McClinton.

The conclusions are not quite contradictory, but whilst Courtillot accepts the reality of an extraterrestrial impact at the end of the Cretaceous, his emphasis is very much focused on the potential role of flood volcanism. Frankel speaks to the great majority and ably brings together the evidence for both a colossal impact and Chicxulub as the point of ground-zero 65 million years ago. Yet despite these differences, both fall into the same trap of special pleading when it comes to extrapolating their favourite mechanism into a universal principle. In some ways Courtillot faces the greater challenge. There is now no reasonable doubt for the end-Cretaceous impact, and this distinguished French scientist accepts the reality. Yet much of the book is a foot-dragging rearguard action which subtly attempts to undermine the established hypothesis. The tone is set by his repeated reference to the impact school, who represent the vast majority, as 'partisans'. This undermining, which tackles such problems as shocked quartz, the age of zircons blasted out of Chicxulub, and the palaeontological evidence as interpreted by such controversial figures as Gerta Keller, actually backfires because it makes no material difference to the overwhelming evidence for the impact. The book begins to sound a bit querulous, and in the end the disinterested reader feels he or she is moving in circles.

What then of the alternative? Courtillot is well known for his espousal of the role of flood basalts, yet as Frankel demonstrates in his book the role of the Deccan effusions must remain problematic given the apparently untroubled persistence of Cretaceous biotas during the first stage of eruptions, untroubled that is until the asteroid arrived. Courtillot then tries to extrapolate the coincidence of flood basalts and mass extinctions. Sometimes one senses the causal links could be correct, most notably with the end-Permian extinctions which are more or less synchronous with the massive eruptions of the Siberian traps. Yet in other

cases, as Courtillot is forced to admit, the link is either weak or there is simply no correlation. Frankel is on much stronger ground when it comes to documenting the impressive range of evidence for an impact at the end of the Cretaceous, yet when he too tries to extrapolate his approach to the other mass extinctions it too fails to persuade. And in some ways Frankel's problem is the more serious. All reasonable calculations suggest the Earth should have suffered about ten very severe impacts in the last 500 million years, each releasing almost unimaginable amounts of energy. Yet, the only really compelling evidence for such an extraterrestrial event is the one at the end of the Cretaceous. Clearly we are missing something obvious, but I doubt flood volcanism is going to provide the unique solution.

To those sensitive to nuances of scientific tradition, each book has its little gems. Courtillot is unashamedly pro-French, and he loses few opportunities of reminding us of the many contributions scientists from that country have made. Somewhat plaintively he asks: 'Why does the public apparently find an asteroid so much more glamorous than a volcanic eruption?' (p. 138). His musings continue that 'the volcanic scenario ... doesn't sink in, it doesn't "hook" people' (p. 139). The perfidious Americans, however, seem to take a different view. Frankel is frankly acerbic. In speaking of the reception of the impact hypothesis in France he writes: 'There was a general mood of defiance to ideas that came from North America. Moreover, there were only a couple of impact experts in France, and they were not high enough in the scientific pecking order to dare stick out their necks ... overall, the opposition to the cosmic theory remained strong, because of the control exerted by senior scientists over the media' (p. 54), but note also that Frankel doesn't lack generosity as he continues 'Strong differences in opinion remain to this day in France, but exchange remains cordial' (p. 56).

Frankel also has some interesting comments on the difficulty of funding high-risk projects. Bruce Bohor, whose discovery of shocked quartz grains in the boundary clay clinched the evidence for an impact, initially was unable to obtain the necessary funding. In science the unwillingness to take risks remains a serious problem. In conclusion, all those interested in the mass extinction debate should have both books to hand and read them consecutively. The order won't matter, but the arguments do.

Simon Conway Morris