BOOK REVIEWS

The Sun and the Rain

FRAKES, L. A., FRANCIS, J. E. and SYKTUS, J. I. *Climate Modes of the Phanerozoic*. 1992. Cambridge University Press, £40 hardback, 274pp. ISBN 0 521 36627 5.

This is a brave attempt to write a small book on a very large subject, and it will undoubtedly be useful to students and teachers seeking an overview of palaeoclimates. Its scope is impressive; from the late Precambrian glaciation to the Holocene warming, with a final chapter on the causes and chronology of climate change. The theme is global climate; inevitably, there is no space for local or regional case histories. Except in the last chapter and to an extent the section on the Quaternary, the emphasis is descriptive; climates are inferred from the geological record rather than predicted from modelling. Deliberately, there is no attempt to provide a general introduction to the various methods used to reconstruct palaeoclimates, and it is assumed that readers will already have some familiarity with Earth history. The climate modes featured in the title are recurring episodes of warm and cool global climate recognized by the authors. They do not coincide with system boundaries, nor with Fischer's well-known Icehouse and Greenhouse divisions: warm, early Cambrian to late Ordovician; cool, late Ordovician to early Silurian; warm, late Silurian to early Carboniferous; cool, early Carboniferous to late Permian; warm, late Permian to middle Jurassic; cool, middle Jurassic to early Cretaceous; warm, late Cretaceous to early Tertiary; cool, early Eocene to late Miocene. The description of the late Cenozoic cool mode is continued in a separate chapter (late Miocene to Holocene) and, of course, the available information for this time period vastly exceeds that for all the rest of the Phanerozoic put together. As the authors recognize, any attempt to impose divisions on a continuum is bound to be to some extent arbitrary, and it remains to be seen whether the modes proposed will be found generally useful. They are certainly thought-provoking; are they cyclic (regular in time, controlled by some as yet unknown driving force), or merely random fluctuations about a mean nearly-steady state, with no regularity in time or intensity? I, for one, continue to find the lack of directional trends in climate, surface chemistry and tectonics during the Phanerozoic more striking than the changes that have occurred; how on earth has the system not run wild (Gaia survived), with so much going on? As the authors point out, even asteroid impacts didn't change things all that much. Life shows direction, all right; but that is another story.

There are some problems with the approach adopted. It is unfair to blame the authors for the deficiencies of their data; they rightly draw particular attention to the problems caused by inconsistent time scales. It is obvious that there is an information deficiency for the early part of the record, and from the text-book writer's viewpoint, overload in the Quartenary. (To try to follow the Younger Dryas saga, you need a subscription to *Nature*, not a textbook; I really think the Quaternary

can only be done in a book of its own). So perhaps the middle chapters are the best. But I think some guidance to methodology should have been provided. As it is, references to problems with particular methods (oxygen isotope palaeotemperatures, for instance) are scattered through the text, and there seems to be no place where the issues are fully set out. In later chapters there is much reference to the carbon cycle and its involvement with climate via the CO_2 content of the atmosphere. I doubt if much of this could be followed by anybody coming new to the subject. Try p.149, for example. We are switched rapidly from bubbles in ice cores, which measure atmospheric CO_2 more or less directly, to benthic foraminifera, and there seems to be a muddle between carbon depletion and carbon 13 depletion. We are then told the whole subject is complex, and are switched again to carbon isotope fluctuations (in what?) and their correlation with orbital parameters. Then back to ice cores. The carbon cycle also figures prominently, but to this reader not altogether coherently, in the discussion of mechanisms in the final chapter.

So what climate indices can we trust, and which can be quantified (not the same thing, necessarily)? It would be good to have the authors' views. Here are a few of mine, and I claim the indulgence of being only a reviewer. Glacial tillites — fine; about the best we have for early times. Glacial dropstones — some OK. Glendonites — probably OK, could do with more discussion here. Oxygen isotopes in carbonates — very convincing in the Cenozoic where we have both surface and deep foraminifera and asssured preservation; so we can get global temperature gradient as well as value, and quantify it; much more work needed for earlier times, especially the early Palaeozoic, but a signal is certainly there if we can read it right. Cenozoic and Cretaceous floras (leaf physiognomy, tree rings) — very good; give information on humidity as well as temperature, almost uniquely. Distribution of sedimentary rock types (evaporites etc.) — relevant, but resolution very coarse and affected by many non-climatic factors. Most fossil distributions — likewise.

Geological and palaeontological climatology has produced many convincing examples of environmental interpretation on a local scale, for instance the second author's elegant studies on the Purbeck of southern England and on polar forests (far more elegantly written, too, than the often turgid prose of the present volume). But adding all these up to a global whole seems at present impossible. So the search is on for indices of global environmental state and change, and these must come, it seems, from geochemical studies of palaeo-oceans or palaeo-atmospheres, for the sea and the air encircle the globe and nourish its inhabitants. At what stage do we stop collecting information and start modelling from it? Can we take Berner's CO_2 models as data, and can we deduce climate from them? Probably not yet, but they are at least as convincing as Exxon's sea level curves, and as worth using to test against one's own data. This review, like the book, raises more questions than it answers; there is much still to do, and let us hope that the book inspires a new generation to do it.

John D. Hudson

All about Everything

EMILIANI, C. *Planet Earth: Cosmology, Geology and the Evolution of Life and the Environment.* 1992. Cambridge University Press, £55 hardback, £19.95 paperback, xiv + 719pp. ISBN 0 521 40123 2 (h/b), 0 521 40949 7 (p/b).

Those of us who were undergraduates and A level students further back in time than we may care to remember will recall that most text books tended to be parochial. Many could appear to be rather turgid, especially if the book was being consulted out of necessity rather than out of interest. However, in recent years many more integrated books have appeared, the authors perhaps aiming at a more aware readership but also, no doubt, trying to avoid producing updated versions of "the same old thing".

There is no doubt that the content of *Planet Earth* is diverse, and the book is divided into discrete sections. It begins with a description of the origin of the Earth according to various religions. It compares the Asiatic religions which weren't, and probably still aren't, concerned with natural phenomena with the religion created by the Greeks which attempted to interpret and explain. Emiliani certainly seems to admire the Greeks for Greek etymology makes several appearances. It is not fundamental, for instance, to be able to spell "diamond" in faultless Greek, but the spelling is given on page 186 should the reader be interested. This first section continues with a list of those who Emiliani considers to be his top twelve scientists of all time, and concludes with a section on various units of measurement.

Part II deals with matter and energy. It is Emiliani's opinion that "Elementary particles and the four forces of nature are . . . so fundamental . . . that it should be an intrinsic part of any introduction to science", a statement with which many would agree. Radiometric dating methods are amongst the subjects covered as well as angular momentum, bonding and sub-atomic particles. Part III is entitled "Cosmology". Starting at the Big Bang, it discusses all objects to be seen, and inferred, in the sky. The history of astronomy is covered as well as distance measurement in the universe.

Part IV is a 200 page section about Geology. All aspects appear to be covered, including sections about the atmosphere and the hydrosphere. Part V, entitled "Evolution of Life and Environment", is marginally shorter, principally biological in content and historically organized. Part VI traces significant scientific achievements from the Minoan civilisation more or less up to the present day through brief biographical details of around 300 scientists.

Finally Part VII is phenomenal as well as being extremely useful. It comprises two appendices and is 100 pages long. There are tables of constants, every conversion factor one could hope for, elemental electron structure, isotope charts, mineral composition charts, a long table of chemical formulae and much more.

There is a lot of basic science of all types in this book, and all readers will find some, but not necessarily the same, parts to be rather heavy going. However, Emiliani usually manages to prevent interest from flagging for

too long. The chapters are well subdivided, and there is an abundance of line diagrams, monochrome photographs and tables, so full pages of text are uncommon. Some parts of the text are anecdotal, but they are no less interesting for that. For instance, almost a page is taken up by an account of the various misfortunes that befell many successive owners of the Hope Diamond. In other cases photographs with short subscripts are used to save space by obviating the need for text, as with the two pictures of an Egyptian obelisk. One picture was taken after the obelisk had been in the desert for 3,000 years; the second picture was taken 100 years later after the obelisk had been subject to the ravages of New York's atmosphere.

Also, there is a "Think" section at the end of each chapter. Here, questions are posed relating to the subject matter of the chapter, but usually bearing little relation to its actual content. The diversity of these "Think" sections is high, from the easy (pumice is highly porous so why does it float in water?), to the hard (how much energy is expended in raising a salt dome of given dimensions?), to the downright obtuse (estimate the mass of your body and calculate how long you would last if you were a virtual person), but the section is always interesting, and it does make the reader think. Questions are often posed that would keep discussion groups going for hours.

Anyone absorbing all the details of this book will have a good grounding in the basics of all the sciences. In fact, it is difficult to think of any subject that has been totally left out. However, such a reader will become aware that he will know just enough about anything to realise that he is an expert at nothing. The problems set out in the "Think" sections will reinforce this view. To cover the amount of ground that Emiliani has done in this book is quite extraordinary, but the depth of coverage of the many and diverse topics must be variable. The section on the origins of life and evolution is very good, but there are also many dated palaeontological line drawings particularly in a chapter that Emiliani describes as "rather boring". Perhaps Emiliani's enthusiasm was beginning to diminish at this point, but maybe it is a subconscious suggestion that the principles of macropalaeontology have not changed as much as those of other branches of science.

Planet Earth is a book that can be read from start to finish and it is also a book that can be dipped into almost anywhere. There is much here to educate and also to entertain, as well as most comprehensive and useful appendices. It is refreshing to come across a book that does not deal with one science in isolation, but covers several subjects and interrelates them. This book cannot, of course, replace any "single subject" books because, although it has the breadth of coverage, it cannot have the depth. However, *Planet Earth* should stimulate, and even rekindle, interest in subjects which may be on the fringe of, or even outside, one's specialism and inspire the reader to find out more.

There are, however, quite a few spelling mistakes. There is one in the first paragraph on page 1 and the captions to both photographs on facing pages 144 and 145 contain spelling errors. To criticise such a marvellous book in this way may at first sight seem petty, but as one branch of modern educational thought believes that it is not necessary for a student to be able to spell correctly, these errors in the text of Emiliani's book merely highlight the fact that *Planet Earth* contains something for everyone.

Robert E. Brown

Setting the Scene

WHITTOW, J. *Geology and Scenery in Britain*. 1992. Chapman & Hall, London. £19.95 paperback, xii + 478pp. ISBN 0412443805.

The author of this new publication was responsible for the revision of three classic Penguin books, *Geology and Scenery in England & Wales*, *Geology and Scenery in Scotland* and *Britain's Structure and Scenery*. All of these are now very much dated both in content and style and *Geology and Scenery in Britain* has been published to replace all of these out of print publications.

The book is divided into 18 chapters, 17 of which address geology and scenery in a regional context, although it could be argued that some of these chapters do not include the most natural of regions from either a geographical or a geological viewpoint. The text is clearly written by a geographer rather than a geologist and consequently the geomorphological aspects receive somewhat more detailed attention than the geological, and in many places human influences come to the fore. This is not a criticism but merely a statement of fact. It would be almost impossible to present a manageable text which dealt in sufficient detail with both. As Britain must have a justifiable claim to some of the most varied scenery and geology for any area of comparable size in the world. Having read and enjoyed the text, it became clear that the book was written primarily for a lay readership. It introduces the relationship between geology and scenery in a simple and extremely readable form and in most chapters there are also references to the human impact on the landscape. It is a clear indication of geographical bias when East Anglia and the Fens are given as much treatment as the geological haven of the Lake District! Although I have made some criticisms from the geologist's viewpoint, however, I anticipate that the book will be well received by the laymen travellers who will find the content rewarding when the scenery of many places they are visiting needs explanation in relation to the underlying strata.

It is useful to find a good bibliography at the end of each chapter. These are through necessity not comprehensive, but some are not up to date and how could such well known authors as R. J. Firman be unfortunately mis-spelt (page 209)! My other criticisms are largely confined to the text figures and plates. I welcome the presence of block diagrams showing the relationship of geological structures to the underlying geology, but there are many other places in the text where such diagrams would have been useful but do not appear. The choice of geological sketch maps also seems to have been somewhat haphazard, and some that do appear refer to detail in small areas whereas the text itself generally gives a much broader treatment. The black and white plates quite simply do not always do

justice to some magnificent geological and geomorphological features. Many readers will, however, appreciate the use of clear and informative diagrams and geomorphological sketch maps, and having in many ways been critical I must conclude with my positive feelings about the book. I would happily recommend it to laymen who wish to know something about Britain's wonderful landscapes and who wish to recognize the basic relationships between the scenery and the underlying geology. It is a book uncomplicated with technical jargon and is very likely to stimulate many into deeper studies.

Ian D. Sutton

Stress and Strain

TWISS, R. J. and MOORES, E. M. *Structural Geology*. 1992. W. H. Freeman and Company, New York. £47.95 hardback, xii + 532pp. ISBN 0 7167 2252 6.

Many readers will be well aware that I'm not a structural geologist. However, I have to lead undergraduate field trips and I have to talk to the students about all aspects of the geology we see, and I also have to admit to a lifelong fascination and bewilderment with geological structures. So, when the specialist structural geologists I approached to review this book turned down the commission, I gladly, if a little timidly, took on the task myself. Somewhat daunting, as I was faced with 532 large-format pages, crammed with detailed text, intricate diagrams and mathematical formulae; but I knew that I would learn a great deal.

The job turned out to be even more rewarding than I anticipated, for this is a handsome book, beautifully produced with clear line diagrams and excellent photographs. It tackles its subjects thoroughly, shirking nothing, and making the reader well aware that proper study of structures involves some advanced mathematics, particularly continuum mechanics. However, the authors adopt an approach of descriptive geology first, leading into the quantitative theory; they emphasize the point that an intuitive and geometric understanding of structures is a necessary solid foundation for more advanced analyses. So, in general, the text allows you to delve as deeply as you wish; you can stop at the descriptive stage, or move on into the experimental interpretations and mathematical theories. Some of the more esoteric mathematics is separated out into boxes for the connoisseurs; I won't reveal how much they meant to me!

The book is intended for students, and chapters 1 to 17 constitute the core of structural geology. The text begins with techniques, including methods of data recording and the nature of data (observational, orientational and geophysical), then follow large sections on brittle deformation (joints and faults) and ductile deformation (folds). Chapters 18-20 are concerned with rheology and the last two chapters cover tectonics, although the authors note that they have a companion volume on *Tectonics* in preparation. Throughout, theoretical discussions of structures are linked with actual examples, predominantly, but by no means exclusively, drawn from North America. I have only one minor quibble; there are so many illustrations that sometimes the text and figures get out of phase, necessitating repeated irritating page turning.

So, I liked this book. It provided me with new information on structures at every level, from the molecular to the global. If my mathematics were stronger, it might even have turned me into a structural geologist! In any event, when next I wax eloquent in the field about the propagation of joints or the niceties of *en echelon* tension fractures, any students who have read this review will know where I gained my insights.

Richard J. Aldridge

Croeso i Cymru

WOODCOCK, N. H. and BASSETT, M. G. (Eds). *Geological Excursions in Powys, Central Wales*. 1993. University of Wales Press, Cardiff. £12.95 paperback, 366pp. ISBN 0 7083 1217 9.

This book is divided into fifteen chapters of geological excursions, typically between ten and twenty pages in length, following a useful section on "Codes of Practice" and a general introduction to Powys.

The excursion chapters comprise, with the author/s in parenthesis: (1) The Ordovician of the south Berwyn Hills (Brenchley); (2) The Ordovician and Silurian of the Welshpool area (Cave and Dixon); (3) The Wenlock and Ludlow of the Newtown area (Cave, Hains and White); (4) Wenlock turbidites between Radnor Forest and the Newtown area (Dimberline and Woodcock); (5) The Machynlleth and Llanidloes areas (Leng and Cave); (6) Llandovery basinal and slope sequences of the Rhayader district (Waters *et al.*); (7) The Ordovician of the Rhayader district (Wilson *et al.*); (8) The Ludlow and Pridoli of the Radnor Forest to Knighton area (Woodcock and Tyler); (9) The Precambrian and Silurian of Old Radnor and Presteigne (Woodcock); (10) The Ordovician igneous rocks of the Builth Inlier (Bevins and Metcalfe); (11) The Ordovician and Llandovery in the Llanwrytd Wells to Llyn Brianne area (Mackie); (12) The Silurian of the Newbridge-Builth-Eppynt area (Bassett); (13) The Silurian of the Wye Valley south of Builth (Cherns); (14) The Old Red Sandstone of the Brecon Beacons to Black Mountain area (Almond, Williams and Woodcock), and (15) Carboniferous Limestone of the North Crop of the South Wales Coalfield (Dickson and Wright).

This book contains well-illustrated excursion guides, including clear maps, stratigraphical sections, simplified geological panels. The photographs are of variable quality. If guidebooks such as this are to include photographic plates, then they should be of high quality and printed on appropriate paper, or otherwise omitted. But this is a minor gripe in what is a useful book for anyone interested in studying the geology of Powys. I have actually used the book on a couple of occasions and I certainly found it helpful in locating sections and gaining a rudimentary understanding of those stratigraphical intervals. I can recommend this book to anyone interested in the geology of Powys, either as a field guide or simply as a source of additional information.

Kevin T. Pickering

Constructive Guidance

WALTHAM, A. C. *Foundations of Engineering Geology*. 1994. Blackie Academic & Professional, Glasgow. £9.95 softback. 88 pp, 211 figures and photographs. ISBN 0 7514 0071 8.

In the not-too-distant past, Engineering Geology used to be the course that was thrust upon the junior assistant lecturers, possibly as their first experience of teaching. Consequently, most courses must have been nervously dull or downright inappropriate. Almost as much could have been said for the text-books which existed at the time; most were dryly factual or barely differed from what was offered as physical geology to all geology undergraduates. Just as a new sense of realism has transformed the appreciation of engineering and applied geology within our science, so a new generation of textbooks has arrived on the scene. These provide varying approaches to the task of registering the inherent interest that lies within the subject, and at the same time, supply the basic facts. In its approach and presentation, this book succeeds at several levels.

First, the text is broken up by maps and diagrams at frequent points. These fit snugly within the text because, for the most part, they have been drawn specially for the purpose. Apart from giving an overall smoothness to the book, the diagrams provide a focus upon the main themes being dealt with. Finding texts dense with data difficult to absorb, I myself appreciate this graphic presentation, and I am sure that this will be the experience of the many overseas students who are so numerous in our applied science courses.

'Easy bites' represents the second success of this book. After ten double page spreads dealing with basic geology (Igneous Rocks, Surface Processes, Geological Structures etc.), there follow short sections dealing with distinct topics such as Groundwater, Coastal Processes, Rock Excavation, and Tunnels in Rock. Other sections deal with practical problems such as Site Investigation Desk Study or S I Geophysical Surveys, emphasising that these are areas of work which students will be expected to undertake as soon as they begin to practise on graduation. Equally useful is the subdivision of discussion of Subsidence into Subsidence on Clays, Subsidence on Limestone, and Subsidence over Old Mines, as each of these sections addresses the problems and the means of coping with them as self-contained exercises. Would that all geological problems were so neatly packaged for our everyday life!

A third appeal is topicality. Several of the examples are drawn from well-known major disasters, but there are also examples that have only just appeared in the daily press, such as the Scarborough landslide of 1993 or the coastal collapses in the Isle of Wight. While these cases will undoubtedly date, they give a freshness and relevance that can be maintained in future reprintings.

Not myself a specialist engineering geologist, I have had the satisfaction of being able to pass comment upon the New Australian Tunnelling Method as it became a matter of national discussion, simply because on page 77 the method is summarized, with its advantages and strengths analysed. I feel equally informed on the matter of strength testing, not, of course, to the extent of carrying out such work, but at least to having some idea of the limits set and the standards expected.

There are two final areas in which this book succeeds where others fail. It was Dr Johnson who said "There is no branch of learning in so few hands as knowing when to have done". Comprehensive as this account is, it is also brief, filling only 88 pages including a six-page index. Equally welcome to the student must be the price, which is accordingly modest and within the reach of a limited budget. This is, however, not just a student textbook, but a book which all geologists could own to advantage.

Eric Robinson

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