BOOK REVIEWS

BENTON, M. J. 2003. *When Life Nearly Died. The Greatest Mass Extinction of All Time.* 336 pp. London: Thames & Hudson. Price £16.95 (hard covers). ISBN 0 500 05116 X.
DOI: 10.1017/S0016756803218343

Michael Benton's book focuses on the largest mass extinction of life on Earth known to science, when indeed, life did nearly die! The book is organized into twelve chapters. Chapters 1–4 provide a historical discourse which explores early discoveries of vertebrate fossils, the development of Cuvier's concept of extinction, and the contributions of Murchison, Smith, Phillips, Lyell and others to stratigraphy in general, to the Permian in particular, and to the development of the concept of catastrophism. I enjoyed these early chapters, into which Benton folds his own personal experiences, and in which he brings alive Victorian geology. Like Benton, I also cut my geological teeth in the Yorkshire dales and on the Yorkshire coast, and yes, I still dream about finding a 'Yorkshire crocodile' of my own! Chapter 5, 'Impact!', heralds the Alvarez 'neocatastrophism' era and the rise of the extra-terrestrial impact 'mafia'. Studies of the Ries Tertiary impact and the Cretaceous–Tertiary impact event and mass extinction are provided as a necessary backdrop to considerations for causative mechanisms for the greatest mass extinction of them all.

Chapter 6 provides an overview of global diversity in the Phanerozoic, distinguishes background from mass extinctions, explores problems of taphonomy and fossil preservation, phylogeny, and recovery from mass extinctions. Chapter 7 homes in on the event. It provides a short historical background to debates on the Permian–Triassic boundary and then discusses the search for a global boundary type section, and formal definition of the boundary at Meishan, South China. It is unfortunate that the formal internationally defined Permian–Triassic boundary 'golden spike' level, correctly shown in Figure 26, is incorrectly positioned in the stratigraphic log of Figure 25! The short sections on dating the end of the Permian and timing (duration) of the mass extinction is rather too dismissive of recent new evidence that places the age of the boundary at 253 Ma and the age of the main mass extinction at 254 Ma (rather than the 251 Ma used throughout the book), and a time duration for extinction events of 1–2 million years (rather than tens of thousands of years). Chapters 8 and 9 provide insights to before and after scenarios, and victims and survivors, in the sea and on land, and in Chapter 10 Benton gives a personal account of his work on the terrestrial Permo-Triassic sequences in Russia, how the vertebrates fared, and touches on dramatic changes in sedimentation at the extinction level.

For the involved scientist and layperson alike, the 32-page Chapter 11 'What caused the biggest catastrophe of all time' might be viewed as the draw-card of the book. This chapter, perhaps rather too briefly, discusses current causative scenarios and controversies and provides Benton's preferred killing model. Following the well documented and generally accepted impact scenario for the Cretaceous–Tertiary boundary mass extinction, which killed off the dinosaurs, and the popular media hype this generated, attempts to blame all mass extinctions on impacts have been rife, and attempts to sniff the impact smoking gun for the greatest mass extinction of all time have been gathering momentum. In fact, it almost seems *avant garde* these days to suggest a causative mechanism other than impact! Benton demonstrates that controversial evidence for an impact smoking gun at the Permian–Triassic mass extinction level (shocked quartz, iridium, buckeyballs with noble gases and all that) is currently equivocal at best. This of course does not rule out an impact but the suggested whiffs of a smoking gun fall far short of establishing an impact as a contributory factor, and less so as a sole cause for the P–T devastation of life on Earth. In the book Prologue, Benton states that he sets out to provide the answer as to whether the biggest mass extinction of all time was triggered by volcanic eruptions or by a meteorite impact. Does the book provide the answer? Well, no, it doesn't, but it does provide a balanced assessment of current hypotheses and presents Benton's own preference (which, by the way, following eight years of hands-on research on the P–T boundary and mass extinction in China, I share) for a killing model involving extended massive volcanism, coupled with other contributing factors. The final Chapter 12 looks to the future and the 'sixth' mass extinction, and shows the relevance of studies of events that occurred hundreds of millions of years ago to the biodiversity crises and climate change issues of today and into the future.

This book follows in the wake of Doug Erwin's *The Great Paleozoic Crisis* (1993), Tony Hallam & Paul Wignall's *Mass Extinctions and their Aftermath* (1997) and Vincent Courtillot's *Evolutionary Catastrophes* (1999). So why another book and what fresh insights does it provide? Well a lot has happened in the last five to ten years, and new controversies have emerged. This book provides a timely and valuable update from an insider's viewpoint that sheds much new light on an ongoing controversial issue in earth sciences.

Michael Benton is to be congratulated on this excellent combined narration of history and philosophy of science, personal scientific insights, experiences and viewpoints, and balanced discussions of currently competing hypotheses on causative mechanisms for the greatest devastation of life on Earth. I thoroughly recommend this book and am confident it will find its rightful place on the bookshelves of both the specialist and general reader.

Ian Metcalfe

GIBBONS, W. & MORENO, T. (eds) 2003. *The Geology of Spain.* xiv + 649 pp. London, Bath: Geological Society of London. Price £85.00, US $142.00; members' price £42.50, US $71.00; AAPG members' price £51.00, US $85.00 (hard covers); Price £27.50, US $46.00; members' price £22.50, US $37.00; AAPG members' price 22.50, US $37.00; (paperback). ISBN 1 86239 110 6; 1 86239 127 0 (pb).
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It is ambitious to attempt to comprehensively cover the geology of a country with as rich a diversity of rock types, ages and structures as Spain in a single text, even within 650 pages. The editors have tackled this by assembling an army of some 160 contributing authors, almost entirely

local experts from Spanish institutions, to contribute their knowledge and assemble this into 19 chapters. The chapters are ordered stratigraphically and within each there is a section on each region of the country. In addition to a chapter on each period, there are also three chapters on tectonics, two on igneous geology (including the Canary Isles) and one on economic and environmental geology.

For a researcher requiring a comprehensive reference text on Spanish geology, this book will inevitably be of considerable value because it contains a wealth of information that is supported by over 3500 references. On the other hand if you want a book to provide a general introduction to the geology of Spain, integrating the tectono-stratigraphic evolution into a coherent story, then this may not be what you are looking for. Overall it is a very 'dense' text, both in a literal sense, with some pages set at a smaller font size and some complex summary diagrams, and also in the sense that it is not a 'light' read. In order to condense everything into limited space, some maps and correlation charts have been reduced almost to the limits of legibility, although there is some inconsistency in the application of space-saving reduction of figures. Overall, however, the production quality is very good, and the editors have maintained very high standards.

Looking through this book made me very aware of the limited geographical extent of my knowledge of the country; there are, however, some regions I have visited frequently and studied to varying extents and this allowed me to assess how comprehensive this book is. In two instances, the Neogene of the Almería area and the Neogene of the Ebro Basin, the stratigraphic and sedimentological coverage is adequate, if a little too brief in my view; considering the number of studies of the Ebro Basin carried out at the universities of Zaragoza and Barcelona over the past two decades, and the size of the basin, a mere eight pages barely does it justice. However, achieving a balance in a book of this type is always going to be difficult, and will never satisfy everyone, so some people will inevitably be disappointed. Anyone who knows the third area I checked on, the Paleogene basins of the southern Pyrenees, will certainly be surprised to see no mention of the sedimentology or stratigraphy of this area. The Jaca, Ainsa and Tremp-Graus basins have long been popular locations for academic and industry field courses because the area is such an excellent case study of integrated tectonic and sedimentary basin evolution: given that this area may be a place many geological visitors to Spain will experience, its omission from this book is difficult to understand. As a reviewer, it also worries me that this book may be rather less comprehensive than it seems: which other areas have been left out? Despite these concerns, this book should be in every geological library, and deserves a place on the desk of anyone who needs a reference text on Spanish geology.

Gary Nichols

PARK, R. G. (ed.) 2002. *The Lewisian Geology of Gairloch, NW Scotland.* Geological Society Memoir no. 26. viii + 80 pp. + map in pocket. London, Bath: Geological Society of London. Price £50.00, US $83.00; members' price £25.00, US $42.00; AAPG members' price £30.00, US $50.00 (paperback). ISBN 1 86239 116 5. DOI: 10.1017/S0016756803238346

Since the pioneering days of Peach, Horne and Clough the Lewisian Gneiss Complex has become a classic geological area, representing the first piece of gneissic crust recognized as preserving a section through lower crust. Because of its accessibility it has become a place where new hypotheses have been tried and tested with varying degrees of success and considerable controversy. Whilst there have been copious papers on the detailed geology and many summaries in the form of regional guides and book chapters, a series of modern memoirs as a data base on the Lewisian has been lacking. The lack of a series that acted as a data repository has probably been detrimental to advances in understanding the evolution of this complex piece of geology. This memoir from the Geological Society at least addresses this gap for the Gairloch area with a meticulous compilation and description of the geological information by Park. The production of this volume represents the culmination of a lifetime's work by one who has been involved with unravelling the geology of the Gairloch area for about forty years. The detailed knowledge of outcrops and their relations probably cannot be bettered. The Gairloch area has long been proposed as the critical area for the interpretation of the Lewisian Gneiss Complex. Whilst the arguments over how important the area actually is will probably continue, it is certainly very important to the understanding of the Palaeoproterozoic evolution of the complex. However, the Archaean geology is more complicated to unravel in this area because of the effects of several superimposed late Archaean and Proterozoic events and therefore is unlikely to be long debated.

The author draws attention to the problems presented by the lack of detailed geochronology of the area and to the consequent difficulties in correlating events over large distances. The publication of the memoir, arguably, has come at an unfortunate time because of recent advances in geochronology and the developing changes in the way that the evolution of the complex is now envisaged. These developments overtook the production of the volume and the author, being aware of this problem, has attempted to explain his retention of some of the old nomenclature, as it would have been an impossible task to change the whole format. In the context of the old view of the complex, the use of the terms Scourian, Inverian and Laxfordian are essentially understandable, although some now need redefinition and others abandoning. Therefore, whilst six of the seven chapters of the memoir have a framework based on the long-established tripartite geographical division of Peach *et al.*, and the Sutton & Watson concept that the gneissic basement was essentially formed in the Archaean as one major unit, in the final chapter the author begins to expound a terrane model. The volume must be approached on the basis that the observations are as good as one will get but, as in any good study, the interpretations may need some modification as time proceeds and different ideas develop. None the less, all the information one needs to discover the geology of this fascinating area is here.

The Introduction explains the long history of research and sets out the Gairloch area in the context of the whole complex and its wider importance in the North Atlantic. The history of research is important because it will not have escaped notice that the study of the Lewisian has been a very fraught, political subject with schools holding very different views that essentially dictated the way that thought on the Lewisian should go. Chapter 2 deals with the early development of those gneisses correlated as Archaean. Without geochronology it is an impossible task to know if one group of gneisses is the same as another and similarly difficult to establish a structural chronology between different blocks of gneiss. However, it is often the case that that is all one can attempt, and so it was here. The Scourie Dyke Suite,

recognized as being a multiple dyke set, is probably of only local structural use and is given an individual chapter. In the Gairloch area they show very complex intrusion forms, probably related to extension. It is emphasized that the suite is only dated from the Assynt area and so there is an uncertainty regarding the timing of emplacement in different parts of the complex.

The main substance of the volume comes in chapter 4, which deals with the Loch Maree Group. There is a complete compilation of the data presented in a number of different papers and for the first time everything is drawn together for analysis. The later aspects of the Palaeo- to Mesoprotoerozoic evolution are covered in chapters 5 and 6. The igneous rocks that preserve good textures despite deformation are going to become very important markers; for example the Ard gneiss, for which there is now a good age, helps limit the ages of the deformation in the Loch Maree Group. The final chapter attempts to draw all of the data together to produce a model to explain the various stages that have been detailed. The major problem identified was the lack of a modern geochronological framework for the area on which to pin the intrusive and structural events. The author produces a plausible model for the Palaeoproterozoic that unequivocally requires different terranes. This is then taken further into the context of a palaeocontinental reconstruction of the North Atlantic region. The volume concludes with a detailed, up-to-date reference list and there is a good index.

It is an interesting question as to which organization should be producing geological memoirs of this type. That the Geological Society now appears to have taken on the task is to be applauded and the quality of production is essentially very good. There are copious illustrations of the geology and detailed locality sketches. One minor quibble is that many of the diagrams have been culled from earlier publications. This leads to a slight difficulty in matching some aspects of the sketches with the map and locating important features, for example the Gairloch Shear Zone. I am sure that the details of some of the ideas presented have evolved over the years and new diagrams specifically aimed at tying in with the map would have given fresher look to the presentation. However, the coloured 1:20 000 scale geological map is a significant improvement on what has gone before, combining the details from the Loch Maree Group supracrustal succession and the Archaean basement. The memoir is highly recommended and will be the first point of search for those scholars of the Lewisian that are seeking the repository of the data on this interesting area. However, whilst it should be in the library, individuals might find that £50 for such a slim volume is rather extravagant. This is a pity because, whilst not being an expert on book economics, given the popularity of the region, with a cheaper price a rather wider market might have considered purchasing the volume.

C. R. L. Friend

HENRIKSEN, N., HIGGINS, A. K., KALSBEEK, F. & PULVERTAFT, T. C. R. 2000. *Greenland from Archaean to Quaternary. Descriptive Text to the Geological Map of Greenland 1:2 500 000*. Geology of Greenland Survey Bulletin no. 185. 93 pp. & map in folder. Copenhagen: GEUS (Geological Survey of Denmark and Greenland). Price 225.00 Danish Kroner (plus postage, handling and VAT); paperback. ISBN 87 7871 069 3; ISSN 1397–1905.
DOI: 10.1017/S0016756803248342

Greenland is regarded as the largest island in the world with a size of 2.2 million km^2 and a history going back nearly 4 Ga. The current 1:2 500 000 geological map of Greenland, compiled by Escher & Pulvertaft, was published in 1995. The present volume represents the accompanying description and includes a folded version of the map. The map is also available separately unfolded, folded in a pocket, or in an atlas of 12 segments. The map and description represent the culmination of detailed mapping and research over the previous 25 years, since the first edition of the map was produced in 1970. The topographic base map has been greatly improved with horizontal corrections of up to 25 km in the north. Offshore areas are now covered using data available from airborne and shipborne geophysical surveys, although the quality of the coverage is variable. This has been stimulated by commercial interest in the hydrocarbon potential especially in offshore western Greenland and in the northern North Atlantic margins. However, most of the country is covered by the largest onshore ice-cap in the northern hemisphere. The exposed geology represents a mere 20% of the land area, only 0.4 million km^2. The inland ice is up to 3.4 km in thickness and has been penetrated to obtain bedrock at only one locality. The geological exposures are limited to the coastal regions and which are up to 300 km wide. The map sheet includes a main panel covering the geological map which sensibly includes parts of the adjacent Canadian archipelago and Iceland. Subsidiary panels cover the main periods of crust formation and orogeny in six time slices and the map keys. Separate keys are provided for the rocks older than 1600 Ma, rocks younger than 1600 Ma, inland ice areas, and the offshore regions. The Harlandian time scale of 1990 is used as a basis. Apart from broad chronostratigraphic allocation, the system of numbering geological units as used on the map is not explained on the map itself, but in the text of the volume this omission is rectified. Perhaps more information could have been given on the map concerning the coloured symbols to make the map more self-explanatory, with, for example, more allocation of group-level names.

The text of the volume is clearly presented and is supported throughout with excellent colour field photographs. The quality of the line drawings, geological maps and cross-sections, all in colour, is very high. The description of the exposed rocks is not just a simple account of the lithological types according to age. In the first half an account is given of the Greenland Precambrian shield, involving crystalline rocks older than 1600 Ma of the Archaean (3100–2600 Ma), Archaean terraines reworked during the early Proterozoic, and early Proterozoic rocks (2000–1750 Ma). These occupy about half of the ice-free area. The second half relates mainly to the sedimentary basins which developed upon the margins of the shield from Early to Middle Proterozoic time onwards, including the Palaeozoic, Mesozoic and Tertiary (including the volcanics, with short sections on the Pliocene, Pleistocene, Quaternary and glaciology). Whilst the map barely gets down to group level units, the text often through the use of tables gets down to formation level for many sedimentary rocks. The volume has a useful section covering the various phases of dyke intrusion, which could not feature on the map. It concludes with short accounts of the offshore geology, the onshore mineral deposits and the petroleum potential. It is well referenced and indexed, and there is a place names register.

The descriptive text of the volume provides an excellent short summary of the geology of Greenland. It is of greatest value to the Greenland general geologist and those trying

to obtain a wider perspective. The references indicate where greater depth can be obtained and include literature which post-dates and modifies the legend on the map itself. I found only minor errors in the areas with which I am familiar. The casual subdivision of chronostratigraphic units sometimes into 'Upper' and 'Lower' and sometimes into 'Early' and 'Late' is both inconsistent and inexcusable. Also the column on the map explanation for unit 50 should extend further down to include a substantial part of the Early Cretaceous. However, I did find that the two uses of East Greenland and West Greenland, as outlined on p. 4, both annoying and confusing in both the map and the volume. It would have been much clearer to use to these terms only as clearly shown on the map, and to use for the broader areas the less formal and perfectly correct 'eastern Greenland' and 'western Greenland'. But these quibbles do not seriously detract from the overall clarity in the presentation and understanding of Greenland's geology as put forward in this excellent volume and its associated map.

A useful addition to the volume, and perhaps filling the otherwise blank inside cover, would have been an outline plan of the 1:500 000 scale geological maps of Greenland available or in preparation by GEUS.

Simon R. A. Kelly

OZIMA, M. & PODOSEK, F. A. 2002. *Noble Gas Geochemistry*, 2nd ed. xiv + 286 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £55.00, US $80.00 (hard covers). ISBN 0 521 80366 7.
DOI: 10.1017/S0016756803258349

It says on the cover that the book 'will be invaluable to graduate students and researchers in the earth and planetary sciences who use noble gas geochemistry techniques'. I am not qualified to comment on the truth of this statement, since I don't or at least haven't yet, but I thoroughly enjoyed reading it, and learned a lot along the way. I would certainly recommend it to anyone like me, who has an interest in all things geochemical but is not a subject specialist in noble gases. It is a skillful distillation of an immense amount of work, presented in an accessible format of well-written text, simple diagrams and summary tables. Postgraduate students embarking on relevant research will find it invaluable, and anyone with a serious interest in Earth evolution will benefit from its exposition of the constraints that noble gases can offer.

The introduction starts with a potted history from discovery of the noble gases a century or so ago followed by sections on a variety of topics useful to the understanding of the rest of the text – geochemical characteristics, constants and conventions, nomenclature, a discussion of the composition of air. A few pages on the pertinent nuclear chemistry close the chapter with the reader better equipped with much of the relevant background.

The physical chemistry chapter is also preparatory, and sets the expected rigorous framework for subsequent data interpretation. It deals systematically with essential controls on terrestrial noble gas behaviour, namely adsorption, solution, crystal–melt partition, trapping and implanting, diffusion and isotopic fractionation. All of this is good fundamental stuff necessary to the remaining chapters.

There are five of these, and together they provide an overview ranging from aquifer systems and cosmic dusts, to mantle dynamics and palaeotemperature investigations. Chapter 3, 'Cosmochemistry', is deliberately short, carefully constrained within the remit of the book (*geo*chemistry). Nevertheless it outlines 'cosmic' noble gas abundances, discusses solar and planetary noble gas ratios and delves briefly into the relatively new field of extrasolar noble gases. I found this latter short section a fascinating introduction to a subject at the margin of my knowledge, and was pleased to find it well-referenced to many landmark as well as recent publications for further exploration.

Back down to Earth with a soft landing in the hydrosphere, the next chapter deals with water. This is the first of three on individual major terrestrial reservoirs, and starts with a discussion of solubility. Noble gases in seawater apparently behave in a broadly conservative way, but with saturation anomalies up to several percent. Reasons for these are discussed, highlighting the importance of juvenile radiogenic He. The treatment of meteoric water flows swiftly into groundwater, with noble gases concurring with other geochemical tests that this is largely meteoric. However, in many geothermal solutions there is evidence for a juvenile component, and this leads into a discussion of juvenile ^{4}He and ^{3}He in the oceans, the continued outgassing of the mantle, and thence to constraint of mass movement and oceanic hydrothermal circulation systems. Finally, palaeotemperature studies are outlined, which use the temperature dependence of noble gas solubility.

The subject of Chapter 5 is the Earth's crust, within which there are several interesting topics despite its overall insignificance to the global noble gas inventory. Comparative data are presented for elemental abundances between deep sea and subaerial sediments, suggesting that only the heavy gases are fractionated between them. Solubility, association with water and adsorption are assessed as explanations. Then noble gases associated with cosmic dusts receive some considerable attention, ranging from their origin (solar, planetary, spallogenic) to sedimentation rate and flux estimates, total exraterrestrial noble gas input and potential retention (or otherwise) during subduction. An outline of the various nuclear reactions between cosmic rays and terrestrial materials leads into theoretical cosmogenic noble gas production rates and examples of observed cosmogenic gases from Hawaii and elsewhere. The crust will clearly host a significant budget of radiogenic and nucleogenic Ne and He, and production mechanisms and rates are dealt with in some detail, proceeding towards a table summarizing noble gases produced over 4.5 Ga of Earth history. Studies of fluid inclusions in granite, and deep drill cores into high-grade metamorphic rocks, have suggested significant mobility of nucleogenic noble gases in crustal environments, with clear implications for nuclear waste disposal illustrated by a short discussion of recent work on the Oklo natural reactor.

Recent fundamantal research into mantle noble gases is summarized in Chapter 6, first by outlining the available data, then discussing their implications for mantle degassing and dynamics. At first sight, MORB and OIB have noble gas abundances and systematics appropriate to degassed and less degassed sources respectively, according well with current understanding of their genesis. Diamonds offer complementary information about the ancient mantle, but interpretation is hampered by uncertainties concerning diamond provenance. Volcanic gases are usually dominated by atmospheric noble gas, and data from xenoliths are complex and equivocal as a result of the many opportunities for contamination. Nevertheless, several fundamental abundance tables and diagrams inform detailed discussion, notably about ^{4}He influx into MORB sources and loss from OIB sources. However, isotopic ratios have the advantage

of being far less sensitive to chemical differentiation, and significant differences (for example in $^{3}He/^{4}He$ between crust and mantle, $^{40}Ar/^{36}Ar$ between MORB and OIB) become readily apparent. After a useful summary table of suggested representative isotopic ratios in MORB- and OIB-source mantle, the discussion moves on to degassing and regassing, including the significance (or otherwise) of subducted noble gases, and implications for the familiar debate about mantle structure and dynamics. The early degassing history of the Earth (required by excess ^{129}Xe in the mantle relative to air) is addressed in sometimes quantitative detail. Leaping forwards to the present day, a global map of current ^{3}He degassing rates is provided, and the imbalance between the radiogenic ^{4}He and heat flux is explored in terms of upper and lower mantle boundary conditions, all with admirable clarity and lucidity.

The final chapter assesses primordial noble gases, and many issues of fundamental importance to Earth evolution that follow from them. Although distinct from Solar System components they are related by mass-dependent fractionation, consistent with the early solar nebula before Earth formation. Problems of Ne fractionation and missing Xe are discussed, as are chronological constraints on early Earth evolution offered by I–Pu–Xe systematics. Difficulties in understanding details of their origin are highlighted and the final few pages summarize the terrestrial noble gas inventory, largely in terms of mantle and atmospheric contributions. There follows a list of several hundred references for those who wish for further detail.

Mike Fowler

HOWARTH, R. J. & LEAKE, B. E. 2002. *The Life of Frank Coles Phillips (1902–1982) and the Structural Geology of the Moine Petrofabric Controversy*. Geological Society Memoir no. 23. vii + 95 pp. London, Bath: Geological Society of London. Price £45.00, US $75.00; members' price £20.00, US $33.00; AAPG/SEPM/GSA price £27.00, US $45.00 (paperback). ISBN 1 86239 102 5.
DOI: 10.1017/S0016756803268345

Like other structural geologists of my generation, I remember the intense frustration on discovering, in the early 1960s, that the laborious weeks spent in plotting hundreds of quartz and mica *c*-axis measurements with the universal stage had been a complete waste of time, and told me nothing that was not already obvious from the minor structures in the field. By then it had become obvious from the work of John Ramsay and others that the recording of structural geometry in the field was the only reliable method of analysing the structure of complex metamorphic belts. We now accepted (with relief!) that quartz orientation data could safely be ignored, pending a satisfactory theory of how they were produced, and that mica orientation was usually pretty obvious anyway. The story of how Frank Coles Phillips introduced the methods of 'petrofabrics' to the study of the Scottish Caledonides, and the controversy that arose from his interpretation, is told in this fascinating account by Richard Howarth and Bernard Leake.

Primarily a biography (written partly to make amends for the lack of an obituary in the appropriate geological publications) this book gives an account of Phillips' life and career, concentrating on his scientific achievements. Inevitably however, because of the critical importance to Phillips of what the authors call the 'Moine petrofabric controversy', they have woven into their account a detailed scientific analysis of the arguments, and of how the controversy evolved and was eventually resolved.

The book traces Phillips' career from his school years to Cambridge (1920–1946) then to Liverpool in 1947 and finally to Bristol, from where he retired in 1952. Phillips was a distinguished crystallographer and mineralogist and, as the authors state, is remembered by geologists primarily for his textbooks *An Introduction to Crystallography* and *The Use of Stereographic Projection in Structural Geology*. However, maybe less well known, and to this reviewer one of the most interesting aspects of his life, was the impact that he had on the development of the study of rock deformation through the work of his students and those who attended his courses. Indeed the list of people that were influenced by his work includes many of the most outstanding structural geologists of the 20th century, and is the true measure of Phillips' legacy. It is a pity that he is remembered for being on the wrong side of the Moine controversy, but the lesson to be learned is that no matter how competent, indeed brilliant, a laboratory scientist may be, his studies may be worthless without a clear understanding of the field context of his work. What seemed to Phillips the great tragedy of the loss of his huge store of Moine petrofabric data in the Liverpool fire of 1947 made absolutely no difference to the geological community and forced Phillips into more productive avenues.

In compensating for the inexplicable lack of an obituary, the authors have produced a much more valuable memorial to this remarkable and influential geologist. Their book is meticulously researched and well written, and will attract those geologists interested in the history of ideas and the dynamics of scientific controversy.

R. G. Park

ROUSE, G. W. & PLEIJEL, F. 2001. *Polychaetes*. xiii + 354 pp. Oxford: Oxford University Press. Price £109.50. ISBN 0 19 850608 2.
DOI: 10.1017/S0016756803278341

From adept swimmers with bulging camera-eyes to tube-dwellers equipped with compound eyes, from worms so small they easily slip through a sieve to others that exceed five metres in length, the polychaete worms exemplify the richness, and to some the wonder, of biological diversity. In this magnificent, but alas rather expensive, volume Greg Rouse and Fredrik Pleijel present a masterly, fascinating and encyclopaedic summary on this important group of animals that, together with the more familiar earthworms (oligochaetes) and leeches, comprise the phylum Annelida. Whilst the core of the book is systematic, the overview at the beginning of the book is concise and invaluable. This review neatly delimits the key anatomical characteristics that in some of the active polychaetes include a surprisingly advanced nervous system with the brain showing a tripartite structure. This presumably evolved independently of the insect brain, and is a reminder that at least these polychaetes are probably far more sophisticated than generally realized. This introductory section is succeeded by the detailed comparisons, which are not only excellently illustrated but complemented by a handsome set of colour pictures. Nor, despite its thoroughness, is this book lacking in those small asides which any author uses to test the alertness of the reader: turn to p. 155 and check the origin of the term "Bobbit worms", while the derivation of the word "sea mice" (for *Aphrodite*) is similarly considerably cruder than might be first thought (p. 73). And that interesting group that the

serious professor terms paraonids, are by "jesting students often [called] . . . 'paranoids'" (p. 61).

There are at least three reasons why readers of *Geological Magazine*, or at least the palaeontological component, would wish to consult this volume. The first is obvious, in as much as the fossil record may not be spectacular but it is still important. Most familiar are probably the calcareous serpulids and the isolated jaws known as scolecodonts, but more celebrated are the famous soft-bodied examples from the Burgess Shale and Mazon Creek deposits. The authors provide a useful overview of this area, touching both on the current debates about polychaete origins in terms of the Cambrian halkieriid–wiwaxiid clade and also offer some welcome criticism. In particular, they cast some doubt on the identification of some of the Carboniferous examples, including a possible tomopterid from the Granton locality (famous for its conodont animals) of Scotland.

The second reason is arguably more important. At one level polychaetes have a rather standard bodyplan, but on this has been built a very remarkable diversity of forms. Because the volume is designed around a standardized format of descriptions, this greatly facilitates detailed comparisons. The range of forms is, therefore, on closer examination little short of startling, and it would be a fascinating exercise to attempt to quantify more rigorously the occupation of polychaete "bodyplan space". Consider, for example, the very odd gelatinous poeobiids, the shield-bearing sternaspids, the vent-dwelling and gutless pogonophores, the oweniids with their bizarre mitraria larva, the amphinomid "fire-worms" with their calcareous chaetae that shatter to release a highly irritating chemical onto the hands of the unwary investigator, and the ectoparasitic *Ichthyotomus* that is remarkably well known, but only on the basis of a single discovery ! And even apparently trivial examples cry out for further examination. What, for example, are we to make of the spinning glands of one of the scale-worm groups (the sigalionids), which produce fibres employed in tube-building (see p. 80)? As the authors note they are similar to those of acoetid polychaetes, which are evidently chitinous. If so, that would be an interesting analogy to the various types of spinning gland that in other groups produce (famously) silk (in the arthropods) and collagen (in the egg-cases of dogfish).

The third reason, which is also a reflection of the remarkable diversity, is the still vexed question of polychaete phylogeny. The authors' overview of this area is a considerable advance on earlier attempts, but there are still plenty of unsolved problems. They include, for example, the rather odd myzostomids, long known for the ectoparasitic association with crinoids and other echinoderms. As they note, however, recent molecular evidence suggests this intriguing group may have nothing to do with the annelids, let alone the polychaetes. This, of course, has not been the first such surprise in recent work on metazoan evolution, but along with the roster of such groups as the mesozoans, myxozoans and xenoturbellids is an important reminder of the plasticity of this Kingdom. This applies equally to the extraordinary examples of miniaturization and the transfer to the meiofaunal habit. This has a palaeontological dimension because of various suggestions that the earliest history of animals was as a cryptic meiofauna, so small as to escape fossilization. In the case of the polychaetes, however, the evidence points strongly to such tiny animals as being derived. As if these were not problems enough, there are also quite a number of "orphan" groups, not least the semi-terrestrial parergodrilids and *Hrabeiella*, the latter inhabiting the forests of Europe.

Ideally, this volume should be on the shelf of any serious biologist, but given its price it is more likely that he or she will be repeatedly consulting it in their libraries, at least until a paperback edition appears.

Simon Conway Morris

SCARTH, A. 2002. *La Catastrophe. Mount Pelée and the Destruction of Saint-Pierre, Martinique*. x + 246 pp. Harpenden: Terra Publishing. Price £19.95 (hard covers). ISBN 1 903544 11 4.
DOI: 10.1017/S0016756803288348

I learnt about the agony, and the stench, and the palpable confusion of so many people who, uncomprehending but dreadfully frightened, had absolutely no idea of the lethal blast about to overwhelm them. Just as when I was a boy and read over and over again Heinrich Harrer's *The White Spider*, involving death on the north face of the Eiger, I knew reading this book what was about to happen in Saint-Pierre, but hoped that this time it would go differently, that the people would evacuate in time. *La Catastrophe* is perhaps a little slow in starting, but quickly becomes a riveting read; it is very thoroughly researched and graphic, following every detail of the 1902 eruption of Mount Pelée, its relatively benign onset, its catastrophic climaxes, its aftermath, and the subsequent heinous accusations.

Most who have any interest in volcanoes know that the devastation and the huge loss of life on Martinique on May 8th and August 30th 1902 constitute the greatest volcanic catastrophe of the twentieth century. Some will know that it was only then that the deadly nuée ardente became known (literally 'glowing cloud' but now variously called pyroclastic surge or pyroclastic density current); others, like myself, will recollect vaguely that there were only two survivors, and a few perhaps will have a notion that evacuation of the town was prohibited because of a forthcoming election. Well, do read this book to get the full, true story; it is not as I thought. Find out how the eruption started with changes in the hot springs and bursts through a small crater-lake, how early lahars swept habitations from the main drainages and produced tsunamis, and then how phases of lava-dome growth and explosive destruction led to the lethal nuées that first devastated Saint-Pierre and then Le Morne Rouge. Be impressed by the growth of the Needle of Pelée, which extruded from the latest dome in the November of that year, like toothpaste from a tube at up to 65 feet per day, to reach by May 1903 an incredible height of almost 900 feet sheer above the dome and some 2000 feet above the vent in the former crater-lake. 'From the ruins of Saint-Pierre it looked like a huge spell-binding finger. It was an obvious symbol, but observers were not sure whether Mount Pelée was accusing the ruins . . . , or the heavens, or even the administration of the colony.' Learn of the real heroes, of the truth behind the failure to evacuate Saint-Pierre, and of the unjust defamation that persisted for long after the eruption ceased in 1905, even until now.

While not wishing to dwell on the macabre, the book is highly instructive in its details concerning the effects of the nuées on both materials, such as buildings and ships, and human beings, and concerning the physical behaviour of those searing blasts. The phenomena even now are not well understood and, just as followed more recent eruptions (e.g. Mount St Helens, Soufrière Hills), such documentation is important not only for historical reasons, but also for the mitigation of risks for the future. That so many people held on to life for hours or days in the most dreadful agony, with

massive burns, came as a shock; that some escaped relatively unharmed beneath the bodies of others, or by ducking briefly beneath the sea surface, affords some lessons. The account of the aftermath, involving the cremation of putrid corpses, of looting, of ghoulish tourism, and of recovery from profound shock, should make a suitable impression on those charged today with ensuring preparedness for volcanic eruption in similar settings. I recommend this exceptional case study to all those interested in volcanoes and their hazards: from amateurs to professionals, teachers to administrators.

La Catastrophe is very well illustrated, with many contemporary photographs and copies of poignant documents, and it is pleasingly produced; its cost, at virtually twenty pounds, seems a tad high, but then it is worth it, as the definitive account of a shattering lesson delivered by nature, and a gripping tale to boot. I hope that when I read this book again those poor inhabitants of the village of Le Morne Rouge will not be forced back home, to die there on August 30th 1902!

Peter Kokelaar

MILNER, A. R. & BATTEN, D. J. 2002. *Life and Environments in Purbeck Times*. Special Papers in Palaeontology no. 68. 268 pp. London: The Palaeontological Association. Price £66.00 (paperback). ISBN 0 901702 73 0.
DOI: 10.1017/S0016756803298344

This volume comprises 16 papers presented at a symposium on the Purbeck environment and the organisms that lived within it held at the Dorset County Museum, Dorchester, in March 1999. The initiative in holding the symposium came originally from a group of vertebrate palaeontologists, and though the symposium later widened in scope, its origin is demonstrated by the fact that 90% of the volume deals with palaeontology, and two thirds deal with vertebrate palaeontology. There is only a limited discussion of dinosaur footprints by Ensom, and very little on palaeobotany. The volume is thus a presentation of the results of ongoing research projects, and relevant work established in the literature, such as Ian West's on the palaeoevironments, Jane Francis on the fossil trees, and Mary Pugh on the algae, are referred to only briefly.

None the less, there is much to interest the general reader. Underhill's paper on structural controls on sedimentation in Purbeck times for the first time sets sedimentation in the group into a convincing framework of synsedimentary extensional tectonics, and is the best explanation of the remarkably varied sequence of sediments and faunas yet published. Radley's paper on the bivalve assemblages, though comprehensive, would have benefitted from some illustration of the faunas. Horne's paper on the ostracod faunas does have excellent illustrations, though it would have helped if both these authors could have taken note of Underhill's work before they wrote their environmental sections.

Considering the vertebrates, Underwood & Rees emphasize the abundance of shark and ray teeth in the Purbeck Beds, and provide some excellent illustrations. A surprising number of amphibian and crocodile skeletons have been discovered, and are well illustrated by Evans & McGowan, and Salisbury. Lizard and dinosaur material is, in contrast, very scarce. The limited amount of material available is described in detail by Evans & Searle, Norman & Barrett, and Milner. However, I feel that this description should have been complemented by a general palaeoenvironmental reconstruction paper setting this terrestrial fauna into its full context, along with considerations of the flora which supported it. Account would also have to be taken of the remarkable recent finds of mammal teeth (Sigogneau-Russel & Kielan-Jaworowska) and insects (Coram & Jarzembowski).

A few niggles: it is unfortunate that the editors were unable to get a unified stratigraphic scheme agreed by all participants. Most do accept the new subdivision of the group into five members initiated by Westhead & Mather (1996), and used subsequently in the new Geological Survey map (BGS, 2000). This new scheme makes the more detailed subdivision of the Purbeck Beds used by Arkell and others into informal, bed subdivisions. However, some authors insist on continuing to subdivide the Group into 15 (or 16) members, with Lower, Middle and Upper Purbeck apparently used as Formations. Is it the Cinder Member of the Durlston Formation, or the Cinder Bed of the Stair Hole Member of the Durlston Formation? The editors cannot even decide whether the authors' Christian names are to be given at the beginning of their paper, at the end, or not at all. Such editorial discrepancies are very few, however, and the work is presented to the usual high standard of the Palaeontological Association.

John K. Wright

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ORESKES, N. (ed.) 2002. *Plate Tectonics. An Insider's History of the Modem Theory of the Earth.* xxiv + 424 pp. Oxford: Westview Press (Perseus Books). Price £24.99 (hard covers). ISBN 0 8133 3981 2.
DOI: 10.1017/S0016756803308349

Like the name 'dinosaur' coined by Richard Owen, the term 'plate tectonics' is set to become common coinage even beyond the confines of science. The story of how the plate tectonic revolution in the Earth Sciences came about is the most interesting and important in this cluster of sciences. And if we must indulge in the present ranking mania, it must rank high as one of the most important new theories in contemporary science. Just how the necessary data was assembled from many different areas of investigation is particularly intriguing.

The editors Naomi Oreskes' and Homer Le Grand's preface sets the context for the testaments provided by 17 out of the three dozen or so main players in the development of the modern theory of plate tectonics. As Oreskes and Le Grand say, they were constrained by space and often had to choose just one member of the different teams and groupings involved in the various areas of work. Ideally, more would have been better and of course if the whole exercise had been conducted just a few years ago it would have been possible to have included some of the pioneers, such as Drummond Matthews, whose careers stretched a long way back and yet have only died in recent years.

Nevertheless, what we have got is a set of 17 invaluable personal accounts, and the editors, being historians of science, are at pains to point out that these testaments are more akin to those produced by historians of old such as Pliny the Younger, eyewitness accounts, often fallable and

partial, rather than historiographies produced by professional historians of science. This is not to detract from their value but it is important to realize the differences as memory can be a strange thing. We use it to make sense of our lives and often that takes the form of stories which have their own trajectory, dramas, etc., no matter how objective we think we are. But likewise, attempts to reconstruct the history of science from published papers is equally frought with problems since these are just as bowdlerised and inevitably expunged of 'false starts and misinterpretations'. No doubt the personal versions presented in *Plate Tectonics* will be trawled over by future historians, arguing the toss over accuracy and interpretation of events and the roles particular individuals did or did not play in them.

The essays range from Naomi Oreskes' historical introduction to the background of plate tectonic theory through to a very interestingly combative and yet reflective one from Peter Molnar entitled 'From Plate Tectonics to Continental Tectonics'. In between there are fascinating contributions from the likes of Vine, Morley, McKenzie and Le Pichon. Finally, there's David Sandwell's epilogue on recent measures of plate movement especially from satellite data in which he also points out the important and often neglected role played by Cold War politics and defence strategies in developing the critical techniques that provided so much of the essential supporting evidence for the development of the theory of plate tectonics.

A number of the contributors admit that the process of writing their essays has forced them, often for the first time, to actively consider the nature of the history of science and its possible role in realizing how science works: '. . . the most interesting historical question to be raised by the discovery of plate tectonics' (Dan McKenzie); '. . . my own views on how advances occur in the earth sciences' (John G. Sclater); '. . . some earth scientists have still not grasped the basic concept of how to do science and still believe, mistakenly, that, if one gathers enough random data, the 'answer' will spring, mysteriously, from that data mass' (John Dewey). Furthermore, authors such as Sclater seriously question the idea 'that advances in the earth sciences occur primarily as a result of hypothesis testing'. Sclater argues that neither 'Harry Hess nor Tuzo Wilson was testing a hypothesis . . . they were creating new concepts out of the synthesis of poorly-constrained observational information'. Nor does Sclater believe advances necessarily result from a paradigm shift during a scientific crisis, as has been advocated by Thomas Kuhn.

Naomi Oreskes started her professional life as a field geologist in Australia and she is now attached to the Department of History and Program in Science Studies at the University of California, San Diego, researching on how scientists choose their research topics and how they decide what methods will give good answers and how to recognise a good answer when they see it. She is the author of *The Rejection of Continental Drift: Theory and Method in American Earth Science* (OUP, 1999). She has been assisted by Homer Le Grand, an American scientist who moved to Monash University, Melbourne, Australia in 1975 and who has been researching the history of plate tectonics ever since, publishing *Drifting Continents and Shifting Theories* (CUP) in 1988.

Plate Tectonics is a fascinating read for anyone interested in the subject, and how can any geologist not be interested in the development of this revolution which has resolved so much but not everything. Inevitably there is quite a lot of repetition and bits of personal 'axe grinding' which will be all too familiar to those who have heard the authors give talks. Over 50 pages of notes and references plus an excellent index provide all the necessary backup to make this a very useful source for historians of science and those who just want to follow through any of the topics. Apart from anything else *Plate Tectonics* is to be recommended to anyone embarking upon research and will hopefully stimulate them into being a bit more reflective about what, why and how they are doing it. They will get quite contradictory advice but then even 'plate tectonics' (which some thought would be the answer to everything) turns out, like the rest of geology, to be infuriatingly more complex and difficult. Curiously, the exact origin of the term 'plate tectonics', coined some 37 years ago, does not seem entirely clear, although attributed to Tuzo Wilson.

Douglas Palmer

CRAME, J. A. & OWEN, A. W. 2002. *Palaeobiogeography and Biodiversity Change: the Ordovician and Mesozoic–Cenozoic Radiations*. Geological Society Special Publication no. 194. vi + 206 pp. London, Bath: Geological Society of London. Price £65.00, US $108.00; members' price £35.00, US $58.00; AAPG/SEPM/GSA price £39.00, US $65.00 (hard covers). ISBN 1 86239 106 8.
DOI: 10.1017/S0016756803318345

Look in any textbook at the curves of changing overall biodiversity through the Phanerozoic and two impressive bursts of taxonomic proliferation are immediately apparent. The first occurs through the Ordovician checked by the end-of-period mass extinction and the second is more long-winded, running from the Mid Mesozoic and through the Cenozoic. But what are the underlying patterns? This compilation of 14 papers which were originally presented as part of the Lyell Meeting in 2001 deals with a variety of aspects of these radiations.

The editors, Owen & Crame, provide a useful overview of the scope of the volume and highlight the nature of the problems and the types of questions posed by those seeking to get to grips with these periods of proliferating biodiversity. Chief amongst these: Why did these dramatic events occur? What was the trigger? Are there similarities between the two? How 'real' was the Mesozoic burst? Owen & Crame point out that both the Ordovician and Mesozoic–Cenozoic increases in biodiversity occur at times when there is an increase in provincialism associated with fragmentation of the continents, sea level rises and climatic change.

The Ordovician radiation affected organisms at a variety of taxonomic levels, from species to class, and put into place the classic 'Palaeozoic Evolutionary Fauna'. The first half of the book is largely devoted to papers investigating the effects of this radiation, particularly on higher taxa. Not surprisingly the patterns of diversification observed vary in different taxa. Bassett, Popov & Holmer establish that the brachiopod-dominated communities so typical of the Palaeozoic were well established in North and East Gondwana shallow-water carbonate settings by the mid Cambrian. They argue that sea level rise in the Arenig, coupled by the expanding area of hardgrounds, enabled a rapid diversification away from this centre. Cope demonstrates that, after their infamous mid and late Cambrian disppearance from the fossil record, the bivalves diversified also out of Gondwana but had their 'cradle' in the shallow-water siliclastic settings. Only in

the late Ordovician did the bivalves find themselves in the low latitude carbonates of Laurentia and Baltica. By contrast Smith, Donoghue & Sansom see the early vertebrates diversifying out of Laurentia. They recognize two major patterns. The major clades of jawless heavily armoured fish which had become endemic in the Cambro-Ordovician spread as the Old Red Sandstone continent amalgamated, whilst the 'naked' clades, e.g. the conodonts, placoderms and chondrichthyians, diversified more rapidly and further becoming cosmopolitan. They attribute the differences in these patterns to the fact that the heavily armoured vertebrates were less mobile and therefore could not disperse across oceanic barriers with the ease of their naked counterparts.

Botting's contribution does not focus on a particular taxon but instead presents an hypothesis that might explain some of the Ordovician radiation. He expands on previous suggestions that there might be a link between this biotic phenomenon and the increase in volcanic activity experienced at that time. He proposes that the overturn of stratified waters associated with ash fall might have stimulated planktonic and benthonic blooms, enhancing heterogenity in the environment, thereby promoting speciation. Although he gives some data from the Builth Inlier they are not yet compelling but detailed collection of data may make them so.

We turn now to papers on the Mesozoic–Cenozoic radiations which occurred in both marine and terrestrial realms. Hart, Oxford & Hudson show how planktonic forams evolved in the early Jurassic from benthonic ancestors in the Tethyan realm. They argue that the habit, so important to subsequent palaeooceanographers, was kick-started by the Toarcian anoxic event but that planktonic taxa were geographically very restricted until the Albian/Aptian expansion of shelf seas. They then achieved near-global distribution, probably as result of the increase in sea levels. Aberhan considers the influence of the so-called Hispanic Corridor on bivalve biodiversity. This putative narrow seaway across Pangaea is hypothesized to have linked the east Pacific with the west Tethys. It has been implicated first in the loss of bivalve diversity in South American fauna by allowing the immigration of more competitive and cosmopolitan taxa from Tethys during the Pliensbachian, and secondly in the re-stocking of the northwest Europe fauna from South America following the Toarcian extinction event. However, in a careful analysis of species-level data Aberhan shows that in both regions immigration rates were rather low. In both regions he suggests that origination of species is more important than immigration. Similarly the role of land bridges in controlling angiosperm diversity in the southern hemisphere is investigated by Cantrill & Poole. They reject the notion of the Antarctic Peninsula as a gateway between east and west Gondwana.

Crame & Rosen tackle the origin of the steep diversity gradient observed in the modern fauna, in particular the tropical high diversity foci in the Indo-West Pacific and Atlantic–Caribbean–East Pacific. They suggest that the tectonic break-up of a homogeneous tropical biota in the early Miocene, along with the rapid cooling associated with the isolation of Antarctica, allowed the subsequent radiation of taxa in the newly created provinces.

The final papers in the volume by Marwick & Lupia and by Marwick look at databases. In a way it is curious perhaps to have these tucked away at the end of the book. Any study that purports to investigate biodiversity depends wholly on the quality of the database and in many papers published on the subject it is difficult to ascertain this. True patterns may be obscured or false ones 'discovered' by biases in the fossil record or faulty sampling procedures. Inaccuracies accrue rapidly whether because of a slip of the finger at data entry, failure to change entries in the light of new data or by differences in techniques between sampling events. Marwick & Lupia urge consistency in scale (both spatially and temporally) and highlight the problems of taxonomic consistency. They suggest that data should always be collected at the finest possible level.

This volume will be of great interest to anyone researching biodiversity, whether in particular taxa or seeking to gain a wider appreciation of process and pattern. In some ways it is disappointing because, aside from the Introduction by Owen & Crame and some of the individual papers, for example Crame & Rosen, it seemed to me that there was little attempt at overall synthesis or search for triggers. Many of the key questions posed in the introduction seemed unanswered either in respect to particular taxa or to the biosphere as a whole. This is not necessarily a bad thing: the book will provide a useful starting point for focusing future research.

The volume has been well edited and as with all Special Publications of the Geological Society it is beautifully produced. Some of the line drawings are a bit fuzzy. At 206 pages this is a relatively slim member of the series and the price may be a deterrent to the individual purchaser.

Liz Harper

BIJU-DUVAL, B. 2002. *Sedimentary Geology. Sedimentary Basins, Depositional Environments, Petroleum Formation.* xiii + 642 pp. Paris: Editions Technip. Price Euros 139.00, US $139.00 (hard covers). ISBN 2 7108 0802 1.
DOI: 10.1017/S0016756803328341

It is important to realize from the outset that this book is intended as a geology manual for petroleum engineering students, as indicated in the foreword. The subtitles provide a better indication of its content than the title: this is not really a book on 'sedimentary geology', but a text which introduces the basics of tectonics (chapter 1) and basin formation (chapter 2), sedimentary deposits (chapter 3), stratigraphy (chapter 4), diagenesis and deformation (chapter 5) and petroleum systems (chapter 6). As a 'course manual', there are advantages to combining this broad spectrum in one text, but price is not one of them. For the 139 euros cover price of this book, one could just about buy three good texts comprehensively covering the same scope (Kearey & Vine *Global Tectonics*, Leeder *Sedimentology and Sedimentary Basins* and Gluyas & Swarbrick *Petroleum Systems*).

The layout of the book is very clear, with effective use of bold and italic typefaces to emphasize points, and the book is generously illustrated with diagrams, although some of the photographs would have benefitted from clearer scales and annotation. With such a wide range of topics, it is inevitable that some are covered in more detail than others, but, given the breadth of the book, a reasonable balance has been maintained. It has been translated from its original French version, and there are occasional lapses in the terminology, such as 'carbonated sediments' when referring to calcareous deposits and 'folia' for layers. There are also some unusual definitions: for example, weathering is considered to be a wholly chemical phenomenon and 'The outcrop [of a bed] is often called a bank . . . a set of banks can outcrop in a massive set that geologists call a bar': it seems likely that something

has been lost in the translation here. In general the approach to the subject matter is similar to other textbooks, although there are some important differences. For example, the deposits of different sedimentary environments are described without using the process-based, lithofacies approach illustrated by graphic sedimentary logs which has become commonplace in modern sedimentology texts. In addition, there are no illustrations of how the deposits of a delta, estuary or any other sedimentary environment would appear in core or on wireline log. The petroleum systems section is short, but provides an adequate introduction to the subject.

It may be that this book will appeal to the engineers and economists in the petroleum industry that it is designed for, but geology students and others looking for a book on sedimentary geology would be advised to consider other texts.

Gary Nichols

DOWDESWELL, J. & HAMBREY, M. 2002. *Islands of the Arctic*. xvi + 280 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £25.00, US $38.00 (hard covers). ISBN 0 521 81333 6.
DOI: 10.1017/S0016756803338348

Islands of the Arctic is a photographic observation of some of the most remote polar landscapes in the Northern Hemisphere. Over the last 30 or so years, the main visitors to these places have been scientists and, in particular, glaciologists. Julian Dowdeswell and Michael Hambrey are among the most distinguished glacial scientists, and have undertaken numerous field seasons at a full variety of locations within the Arctic. This book is a compilation (a very small sample in fact) of the authors' personal photographic collections. As scientists, their field locations have been chosen for scientific value. In the Arctic such places have a unique yet rarely described geographical beauty. This photographic assemblage is, therefore, an exclusive insight into the environments of the high northern latitudes as seen through the lens of scientific exploration.

This is more than simply a collection of photos, however. The authors' scientific instincts are perceptible through the organization of the volume into chapters relating to specific geographic themes. The reader is guided through the localities within each chapter by simple maps of the Arctic. This is critical to a themed volume where neighbouring photographs are from different continents, and it works well here. Each of the chapters is accompanied by instructive sections of text aimed at informing the non-specialist about the scientific background.

The book mainly covers the physical environment such as surface processes (glaciers, frost action, rivers) and ice–ocean interactions. The book also looks at the fauna and flora of the Arctic Islands, which is bound to appeal to many readers; after all, everyone loves a polar bear picture! These chapters comprise what is expected of a book about the Arctic islands. Importantly, however, the book ends with two chapters devoted to human influences on the Arctic. First, in Chapter 9 entitled 'Indigenous Peoples, Exploration and Environmental Impacts', the wilderness illustrated so carefully in former chapters suddenly forms the backdrop to human activity. The organization is quite clever in this regard. Up to this point the reader is provided with an overview of the physical environment without much attention to humans. In this chapter, the settings are now familiar, which makes the overlay of human activity (both indigenous and recent) all the more obvious.

The book ends with an assessment of the Arctic in the future, and a timely warning that expected warming of a few degrees over the next 100 years will have a dramatic effect on the physical and biological environments that this book so well documents.

I'm told by one of the authors, that the quality of some of the photographs is not as good as the top copy. I have to say that it hardly matters if it is the case. The photographs, all in colour, do good justice to the environments which they illustrate.

The market for this book is, primarily, the tourists that now frequently cruise to the Arctic Islands. It will also be of interest to anyone who has visited the Arctic, or who has interests in finding out about the most remote and remarkable landscapes on Earth. I thoroughly enjoyed reading this book, and am sure that those who purchase it will gain an appreciation of the variety and beauty of the Arctic Islands, and their scientific value.

Martin J. Siegert

KILBURN, C. & MCGUIRE, W. 2001. *Italian Volcanoes.* Classic Geology in Europe Series Volume 1. vii + 166 pp. Harpenden: Terra Publishing. Price £12.95 (paperback). ISBN 1 903544 04 1.
DOI: 10.1017/S0016756803348344

The Italian volcanoes have played a pivotal part in the development of human interpretation of volcanic behaviour from the myths of the Greeks and Romans through to modern volcanology pioneered in Italy by Alfred Rittmann. This book is designed as a practical guide to what the authors identify as the four key volcanic districts: Somma Vesuvius, Campi Flegrei, the Aeolian Islands and Etna. The authors have over 30 years' experience each on Italian volcanoes and are well placed to write this book.

The first chapter provides a brief overview of the Quaternary volcanoes of Italy discussing their tectonic association and the petrology of the magmas. An introduction to styles of volcanic eruption is also provided. Very sensibly, the chapter includes a safety guide to visiting these active volcanoes. As is the structure throughout the book, there are no references in the text but a brief bibliography of key books, journals and websites is provided at the end of the chapter. Sadly, websites are ephemeral and many of the addresses are already obsolescent.

The first volcano to be considered is Somma Vesuvius. Vesuvius was part of the grand tour in the 18th century and was the principal focus of the observations of Sir William Hamilton; as such it was central to the birth of the science of volcanology. The chapter begins with a brief overview of the geological history and structure of the volcano followed by an account of the historical activity from 1631 to 1944 when the volcano was in virtual continuous eruption. A more detailed description is provided of three classic eruptions: AD 79, 1631 and 1944. These eruptions are of interest for different reasons. AD 79 is one of the most famous eruptions with the destruction and burial of Pompeii and Herculaneum, the death of the Roman admiral, Pliny the Elder, and the perceptive description of the activity viewed from Misenum by Pliny the Younger, who gave his name to this style of activity. The eruption in 1631 was subplinian in size and one of the most violent of Vesuvius in

historic times. This eruption is used as a template for the hazard and risk evaluation of Vesuvius. In March 1944 the most recent eruption occurred, taking place as Allied forces moved north of Naples towards Rome. This was not a big event but lava flows destroyed the town of San Sebastiano. There were a number of fatalities from this eruption and the authors draw attention to three aspects which are a valuable lesson in the fact that simple measures could avoid casualties. Accumulation of ash on houses led to roof collapse with a number of fatalities, seepage of CO_2 which ponded in depressions led to two deaths in a basement shelter, and two deaths were caused by a steam explosion as lava advanced through San Sebastiano. These accounts are followed by brief sections on rock chemistry and petrography, the magmatic system and the future. The chapter ends with suggested excursions. The first excursion runs from the coast up to the crater. The helpful hints reflect the local knowledge of the authors. The supporting map, however, is rather confusing and there are some inconsistencies between the key, the caption and the map. The other main excursion runs round the base of the volcano with the opportunity to examine deposits and some archaeological sites at the Pollena and Ranieri quarries. The excavation of the Villa di Poppea at Oplontis provides unrivalled opportunity to examine the AD 79 deposits of the lapilli fall, pyroclastic surges and pyroclastic flows that engulfed this Roman country house. The authors do provide information on Pompeii and Herculaneum but are right to concentrate on some of the other informative but less well known sites.

Campi Flegrei, the volcano immediately to the west of Naples, is the topic of the next chapter. The Campanian Ignimbrite formed as a consequence of a major explosive event at Campi Flegrei around 34 000 years ago and is one of the most important Quaternary eruptions of Italy. The last eruption of Campi Flegrei was in 1538 and this provides a good opportunity to discuss magma interaction with groundwater, hydromagmatism or phreatomagmatic activity, which is a theme of this chapter. The excursion described takes you to Monte Nuovo, the cone of the 1538 eruption, and to the town of Pozzuoli. The caldera of Campi Flegrei is famous for its vertical movements, leading to an oscillation about sea level, and this can be readily appreciated in Pozzuoli. The Roman columns of Serapeo record some of these movements each with a band of marine mollusc borings some 3.6 m above the base. The last episode of uplift was 1983–85 which raised Pozzuoli some 1.8 m. This episode was associated with seismic activity which led to considerable damage and temporary evacuation. The excursion continues from the harbour up the hill past the Roman amphitheatre into the crater of Solfatara. This crater with its fumarolic activity is another Italian site which has given its name to a formal volcanological term. Campi Flegrei is a fascinating place but you need a guide like this to enable you to find the geology and avoid some of the pitfalls of this chaotic corner of southern Italy.

The Aeolian Islands are the topic of the next chapter. The book selects four of the islands, Vulcano, Stromboli, Lipari and Panerea for consideration. Vulcano, the southernmost island, gives its name to all volcanoes. The last eruption in 1888–90, observed by Giuseppe Mercalli, led to the definition of vulcanian style activity. Landing at Vulcano the immediate sulphurous smell brings home the fact that this is very much a volcano. Excursions lead up to the rim of the Fossa Cone with the fumaroles and sulphur deposits, then along the margin of the Fossa Caldera to examine rhyolite lava domes, pyroclastic surge deposits and the caldera relationships, and finally across the beach north of the harbour to see the famous hot mud pool and over the isthmus to Vulcanello which emerged from the sea in 183 BC. Stromboli is probably the best known of the Aeolian Islands and is one of the few volcanoes in the world that is almost continually active. A description of the most violent historic eruption in 1930 which killed six people is provided. This eruption produced a tsunami and is particularly relevant in view of the recent more vigorous activity of Stromboli. The excursion provides guidance on an ascent to view the summit craters. The words of caution should be strictly followed as there have been a number of casualties among tourists in the summit area. A trip to Lipari allows an opportunity to relax in the pleasant town. The excursion takes you north to the rhyolitic Monte Pilato complex which last erupted between AD 580 and 729 producing the distinctive white pumice at Porticello and the Rocche Rosse obsidian lava flow. On the northeast of the island near Quattropani good pyroclastic surge deposits can be seen. The final island to be visited is Panarea which has not erupted in historic times but still has submarine fumarolic activity.

Mount Etna dominates the volcanoes of Italy and like Stromboli is almost always active. An informative overview of the volcano is followed by an account of the 1669 eruption. The eruption started on 11 March near Nicolosi on the southern flank of the volcano, and by 16 April the lava had reached the city walls of Catania on the coast. There is now almost unbroken urban sprawl from Catania up to Nicolosi and such an eruption today would have devastating consequences. There are brief sections on the rock chemistry and petrography and the present magmatic system of the volcano. Three major excursions are outlined. The first starts at Etna Sud by the Rifugio Sapienza. The cable car has sadly been put out of action by the eruptions of 2001 and 2002 since the writing of this book. The morphology above Montagnola has also been changed by new cones and lava flows from the 21st century eruptions. The summit area of an active volcano like Etna is a dynamic place; it can also be a dangerous place, and guidelines should be strictly followed. The next excursion into the Valle del Bove is difficult and demanding but can be very rewarding if the weather is good (the Valle del Bove has a habit of filling with cloud). The final excursion is on the southern flank with an opportunity to see into the southeast end of the Valle del Bove from an overview, examine the distal snout of the 1991–93 lava flow field, the Chiancone alluvial fan, the classic pillow lavas at Aci Castello and trachytic ignimbrites near Biancavilla.

The book is written in an engaging style and is very much a guide providing outline information without getting trapped in the detail. There are helpful hints to support the reader in travelling to these sites in southern Italy. There is a glossary of volcanological terms, but this does not include the rock types mentioned. At 166 pages this a manageable book and with a robust, flexible cover ideal for the field.

Angus Duncan

BUCHER, K. & FREY, M. 2002. *Petrogenesis of Metamorphic Rocks*, 7th ed. xvi + 341 pp. Berlin, Heidelberg, New York: Springer-Verlag. Price Euros 49.95 (+VAT at local rate), SFr 86.00, £35.00, US $59.95 (hard covers). ISBN 3 540 43130 6.
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This revised edition of what was once Winkler's *Petrogenesis of Metamorphic Rocks* is very strongly based on the sixth

edition (which is now nearly 10 years old). The book comprises several chapters on the nature of metamorphism and metamorphic rocks, followed by a review of the mineral assemblages developed in common rock types.

The introductory chapter ('Definition, Conditions and Types of Metamorphism') has been substantially revised and lives up to its title. The authors, like many others before them, do not completely succeed in coming up with a clear way of defining the boundary between diagenesis and low-grade metamorphism, an issue made particularly complex when the effects of hydrothermal processes have been operative. The frequent lack of equilibrium is clearly also a factor. Even the Subcommission for the Nomenclature of Metamorphic Rocks (http://www.bgs.ac.uk/SCMR/), like the authors here, has limited success with this issue. Similarly, the high-temperature limit of metamorphism is not easy to pin down: crustal rocks remaining as the residue after partial melting are clearly within the realm of metamorphic petrology although definitions do not always reflect this. The latest draft proposal from the Subcommission does present a clear wording that addresses this issue.

Chapter 2 ('Metamorphic Rocks') introduces nomenclature and also the graphical representation of metamorphic assemblages. The following chapter ('Metamorphic Processes') reviews extremely briefly the thermodynamics of metamorphic reactions before looking at key controls on temperature and pressure before considering *P–T–t* paths. A more extensive discussion of chemical reactions in the context of metamorphism follows. This involves both the thermodynamics of reactions and the construction of phase diagrams. This is all good material and with a little reorganization this could be an excellent introduction to the quantification of metamorphism. Chapter 4, extensively revised, entitled 'Metamorphic Grade', covers facies (much improved with discussion linked to a basaltic composition, isograds, thermobarometry, etc.).

Part II of the book reviews the assemblages developed in simplified chemical systems that model naturally occurring lithologies. Chapter 5 ('Metamorphism of Ultramafic Rocks') is also revised substantially from the sixth edition, and starts with a rather more logically presented analysis of the metamorphism of fully hydrated serpentinite than that edition. This is followed by a look at assemblages in the system CMASH, carbonated ultramafics and several other topics. Chapters 6 ('Metamorphism of Dolomites and Limestones'), 7 ('Metamorphism of Pelitic Rocks'), 8 ('Metamorphism of Marls'), 9 ('Metamorphism of Basic Rocks') and 10 ('Metamorphism of Granitoid Rocks') are little changed in content from the previous edition. The diagrams in these chapters (and elsewhere in the book) are in general rather clearer than in previous editions.

The minimal changes seen in Part II of this book between this edition and the previous one are a little surprising given the almost continuous revisions to the thermodynamic databases available to petrologists, and the recent literature documenting, for example, high-pressure assemblages in some detail. As noted in the sixth edition, calculated phase diagrams rely upon thermodynamic databases and hence experimental data, and errors in these data sources will lead to erroneous predictions. Yet many of the diagrams in the book remain unchanged in the location of reactions. Are the diagrams unrevised, or is it that the newer databases do have a negligible effect on calculated reaction conditions? – in which case the fact should be acknowledged.

It is not clear who is the target audience for this book. In the UK and many other countries, this book is unlikely to be used in teaching metamorphic geology to undergraduates, as it does not cover any of the petrographic aspects that are such an important facet of the study of metamorphic rocks. Personally, I have found the previous edition of this book useful over the years when I need to say something about equilibration conditions of metamorphic assemblages, and will undoubtedly continue to use the new edition in this way. However, this sort of usage is unlikely to lead to a big audience for the book. In many ways this is a shame, as it does represent a unique summary of what is known about metamorphic assemblages across *P–T* space.

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