BOOK REVIEWS

LISLE, R. J. & LEYSHON, P. R. 2004. *Stereographic Projection Techniques for Geologists and Civil Engineers*, 2nd ed. viii + 112 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £50.00, US $85.00 (hard covers), £19.99, US $35.00 (paperback). ISBN 0 521 82890 2; 0 521 53582 4 (pb).
DOI: 10.1017/S0016756805210439

Twenty-first century students are prone to ask why we still need a graphical way of solving 3D problems in structural geology. Surely, plugging the data into a computer program will yield the right answer? Well, all structural geology researchers and teachers know that it generally won't, or at least not unless the problem has been accurately visualized and formulated. Stereographic projection techniques promote 3D understanding of the geometry of geological structures as well as providing some numerical results, and are likely to remain central to structural geology teaching for some time to come.

The first edition of *Stereographic Projection Techniques* – subtitled *for structural geologists* and published by Butterworth Heinemann – was well reviewed as a clearly written and illustrated guide for undergraduate students. However, its effectiveness and, no doubt, its sales were reduced by its presentation. The consistent double page layout, with text on the left and illustrations facing were a success, but the variable quality of the line drawings and photos were both criticized by reviewers. There was only one short section on engineering geology applications, a specialized but economically important field with a significant readership. All these factors have been satisfactorily addressed in the second edition. The line drawings have been redrafted, the photos reproduced clearly and extra sections added on slope stability analysis. The rest of the text remains much the same as in the first edition: a step-by-step tour through all the common procedures using stereographic projections, and a number of less frequently used ones for good measure. This is the best student manual available on stereographic techniques, and it deserves to be in all geological teaching libraries.

Nigel Woodcock

ALEXANDER, D. & WHITE, R. S. 2004. *Beyond Belief: Science, Faith and Ethical Challenges.* 220 pp. Oxford: Lion Publishing. Price £8.99 (paperback). ISBN 0 7459 5141 4.
DOI: 10.1017/S0016756805220435

The arena of science and religion shows no signs of emptying, rather the crowds continue to pour onto the terraces to admire and cheer on their particular heroes. Far from running out of steam, if anything discussion and debate are continuing to intensify. And it is not difficult to see why. Be it the spectacular images from deep space or the mounting alarm about global warming, it is clear that science can not only inspire but also terrify. Add to this such questions as the 'wisdom' of genetic engineering and nano-technology, and it is easy to see why discussion, debate and some level-headed thinking are of increasing importance. By no means everyone will accept that a religious dimension is a necessary ingredient to this broad area of scientific meaning and responsibility, but at the very least we should think carefully on how to find and keep the good before ditching centuries of careful reflection. Not least we need to know how to act for the best in the worst of circumstances.

Here two distinguished Cambridge scientists, the biologist Denis Alexander and Bob White, a geophysicist, and both committed Christians, take the argument forward that not only are science and religion (as Christianity) compatible, but they can provide a fertile matrix to address many of the major ethical questions that face all of us as science and technology increasingly dominate, if not overshadow, our lives. A key card Alexander & White play is our duty to alleviate human suffering and mishap. In this respect there is no doubt that science has been an extraordinary force for good, even if glaring inequalities persist.

In clear prose and via forceful arguments they argue, sometimes passionately, that not only are science and Christianity compatible, but isolated from each other they impoverish our appreciation and sheer wonder at the nature of Creation. They are also careful, and rightly so, to distance themselves from the stranger branches of science and religion, notably 'scientific' creationists and the Intelligent Design (ID) movement. In this latter respect some readers might have wished for a more extensive demolition, but these aspects are incidental to the main purposes of *Beyond Belief.* The overarching aim and the recurrent theme is an attempt at a reconciliation of science and religion by identifying the common ground.

How well Alexander & White succeed in this respect inevitably will elicit different answers. To the Christian believer *Beyond Belief* will be a welcome addition to a delineation of a rich and wonderful world, which is nevertheless deeply flawed. To the open-minded sceptic, if such really exists, at the least this book should provide food for thought. But the hardened sceptic, hands flapping in irritation at the mere mention of religion; how will he or she respond? I fear that here *Beyond Belief* will be of little consequence. This will not be for want of trying, but we should always recall Cardinal Newman's dictum that whilst scientific evidence can be compatible with religious truth, the latter can never depend on science for its basis. Hence the perennial risks of using science as part of the Christian apologetic.

So believer and open-minded sceptic will find much to enjoy in this book. But there is another category of believer that, while welcoming much of what Alexander & White have to say, may still raise a theological eyebrow. This concerns the problem of so-called radical evil. To be sure the authors freely acknowledge that not all is perfect, but there is hardly a whiff of the malevolent Screwtape, the classic tempter summoned by C. S. Lewis as a very English introduction to deep and pervasive evil. Hope must be for the best, but history and even our own lives are littered with shortcomings, failures or worse. The relevance of this to an accelerating technology, and in at least some quarters of science a seemingly blithe disregard for moral responsibility, will be self-evident to anyone who sees the corrosive effects of piecemeal accommodation to vested interests, greed, and tireless self-regard. Here is an area that *Beyond Belief* largely chooses to skirt.

In conclusion, this short and readable book is a useful addition, to be carried by anyone entering the arena of science and religion, and – who knows? – perhaps is contemplating a longer journey. To the believer it will indeed show the compatibilities of science, while to some open-minded sceptics it may niggle uncomfortably. This alone will make *Beyond Belief* of great value.

Simon Conway Morris

GYR, A. & KINZELBACH, W. (eds) 2003. *Sedimentation and Sediment Transport*. Proceedings of the Symposium held in Monte Verità, Switzerland, from September 2nd to September 6th, 2002. x + 271 pp. Dordrecht, Boston, London: Kluwer Academic Publishers. Price Euros 115, US $113, £72 (hard covers). ISBN 1 4020 1266 7.
DOI: 10.1017/S0016756805230431

In order to complete reviewing *Sedimentation and Sediment Transport*, I first had to prise the book away from several of my colleagues, proof indeed that this book is of great interest to Earth Scientists. The book sets out to address what the editors see as a stagnation of research in the fields of sedimentation and sediment transport over the last several decades, and provides a series of papers from a symposium held in Switzerland in September 2002 that brought together workers from across mathematics and the natural sciences.

The breadth of the text is impressive, from theoretical studies of turbulence, through physical experiments, to field studies; and with applications including rivers, aeolian systems, estuaries, coastal zones and gravity currents, as well as many purely generic studies. In total, there are some 41 contributions, with an average paper length of under seven pages. Half of the articles are just four pages or less, and only five reach double digits. As such, the book at times reads more like a set of extended abstracts than as a series of stand-alone papers. Many of the contributions are in fact updated abstracts of work that has been published elsewhere, with the previous work well referenced at the end of each paper, whilst others highlight papers that will be published shortly. However, there appear to be a number of advantages to such a format in this case: it allows a very broad range of science to be encapsulated within a single slim volume and the material is accessible to a wide readership. Furthermore, the reader can very rapidly acquire a broad overview of progress in these topics, and yet there are sufficient references for the reader to be able later to examine any aspect in greater depth. For all these strong points, the volume can at times be a little frustrating with insufficient background or methodology in some of the contributions, and the disappointment of not having the full-length articles in the volume (for those areas that are of most interest to the reader) and therefore having to search out the associated references.

The book is split up into eight categories covering: i, turbulence; ii, turbulence and sediments; iii, turbulent structures and sediment transport; iv, two-phase flows; v, self-organisation in sediment transport; vi, self-organisation in sedimentation processes; vii, problems related to field measurements and inputs required for numerical models; and viii, measuring techniques. Within each of these categories there is much to interest the Earth Scientist, including: sediment entrainment as a function of coherent flow structures, interactions between particles and turbulence, velocity lags between fluid and particle phases, and growth and development of bedforms. Other topics include sorting of sediment beds, suspended sediment transport relationships for large sand-bed rivers, and numerical modelling with both large eddy simulations and direct numerical simulation to reproduce large-scale coherent flow structures. There is also a raft of new experimental techniques illustrated that allow for unprecedented spatial and temporal measurement of velocities, in both clear and particulate flows, and of particle velocity, grain-size, and sediment concentration in particulate flows. The rapid advances illustrated in theory, experiment, and in numerical modelling promise great advances in our understanding of sediment problems in the future – an area with huge societal benefits. It is to be hoped that funding agencies covering Earth Sciences will also recognize this potential!

The general quality of the text and figures is reasonable, although not all of the papers have the figures integrated with the text, and a few of the figures are extremely difficult to read. Several of the papers also suffer from poor text reproduction. Pleasingly, the indexes are useful enabling the reader to search by subject or author.

In summary, the editors have succeeded in bringing together a volume that illustrates that there is huge progress being made in the fields of sediment transport and sedimentation. The collected papers provide a snapshot of this progress and encompass many of the exciting topics in these fields. This volume is a must for any library that has researchers in fields that incorporate particulate flow. For individual Earth Scientists and many colleagues from other disciplines, this book will undoubtedly stimulate ideas and introduce important areas of the science outside their core discipline.

Jeff Peakall

VANCE, D., MÜLLER, W. & VILLA, I. M. (eds) 2003. *Geochronology: Linking the Isotopic Record with Petrology and Textures*. Geological Society Special Publication no. 220. viii + 266 pp. London, Bath: Geological Society of London. Price £75.00, US $125.00; members' price £37.50, US $63.00; AAPG members' price £45.00, US $75.00; hard covers. ISBN 1 86239 146 7.
DOI: 10.1017/S0016756805240438

Having first encountered the Geological Society Special Publication series when volumes in the low teens were being published, the realization that it has reached number 220 had me reflecting on the human time scale; slightly ironic since this is a collection of papers about geological time. Over twenty years or so, this series must have been producing at about one issue per month and will occupy over five metres of shelf space in any library fortunate enough to have collected the full set. The latest edition describes some of the recent developments in constraining process rates of metamorphism and deformation.

Geochronology is an important sub-discipline. Not only is time an essential ingredient in all geological research, but the discovery of the antiquity of geological time was a truly revolutionary idea. These notions when proposed by the likes of Hutton and Darwin were controversial, to say the least. When confirmed through the efforts of Rutherford, Holmes, Patterson, Weatherill, Krogh, Moorbath and many others, the enormous age of the Earth shifted the balance between competing philosophies. Today, one cannot be well informed and doubt that the Earth is aeons old. Some do, but they do so in ignorance of, or with contempt for, one of the scientific triumphs of the twentieth century.

With such a pedigree, where is geochronology heading next? Two obvious challenges are (1) to refine further the time scale throughout the geological record, and (2) to relate

high precision ages to the pressure and temperature record available from the petrology of metamorphic rocks. Modern geochronology is less about simply asking 'how old is this rock?' and more about finding how quickly and how long the processes lasted that are recorded in that rock. Derek Vance and his co-editors, Wolfgang Müller and Igor Villa, in their introductory paper, identify the limitations as the 'perfidy of nature' (i.e. the availability of suitable samples to date), the 'anaemic technology' (i.e. the quality of our mass spectrometers) and the 'inadequacy of our understanding' (of how chemical, textural and isotopic sub-systems interact within a deforming fluid–rock system).

Following the editors' introduction, the 14 papers in this collection are grouped into four sub-themes. Three papers address the crucial link between accessory phase chronometers and petrological information. This is an important issue because some of the best chronometer minerals, e.g. zircon, are minor phases which are difficult to relate to the overall deformation fabric of the rock and are composed of trace constituents that are not strongly linked to bulk composition. A common frustration for the geochronologist is to produce a precise age through painstaking analysis only then to encounter disagreement amongst the geologists about where the dated zircon fits into the temporal evolution of the overall rock fabric.

Four contributions address advances in obtaining chronologies from major mineral phases. Inevitably, the focus is on Sm–Nd dating of garnet-bearing assemblages and Rb–Sr in mica. The papers mix analytical developments with applications of established methodology. In particular, Anczkiewicz & Thirlwall describe a sulphuric acid leaching method that increases the reliability of garnet dates by removing relatively low Sm/Nd phosphate inclusions and illustrates the importance of understanding the sample material as a key to successful geochronology. U–Pb dating of titanite (Romer & Rötzler) also falls in this category on the basis that titanite, although a minor phase, is identifiable as a reaction product of major phase reactions.

Two papers focus on developments in *in situ* geochronology using the Rb–Sr system. Cliff & Meffan-Main describe how their micro-sampling approach to mica geochronology allows dating of the very mineral defining the structural fabric. Vanhaecke *et al.* describe further refinement of their reaction cell ICP-MS method that opens the possibility for mica (and other high Rb/Sr phase) geochronology using laser ablation methods.

The remaining papers are gathered under a catch-all section 'Understanding transport processes in rocks'. The transport processes addressed range from metamorphic reaction rates through migmatite melt segregation, garnet zoning, mantle metasomatism and diatreme emplacement, to Ar diffusion in muscovite.

The overall impression obtained from this snapshot of the state of geochronology is of a sub-discipline that made its mark through the glory days of dating the Earth and the timescale of its formation from meteorites, but which has much yet to offer in constraining process rates in geology. New tools and new methods are evolving that will deliver this critical quantification of the Earth system.

As ever, the book is produced to the usual high standard of the Geological Society Publishing House and, following the established format, is a sturdy hardback. There is an attendant price of course, and those five metres of shelving are carrying over £16,000 at today's price. Holding the complete run of these volumes is therefore a similar commitment to a single journal subscription. When librarians and their readers are faced with difficult choices for their cash-limited budgets, one wonders whether the extremely eclectic mixture of this series counts as asset or liability?

Finally, I think this is a good example of how the Geological Society Special Publications should work. The idea for it came from a session at the 2002 V. M. Goldschmidt meeting in Davos, but this is more than a collection of the papers presented at that meeting. I think there should be more of this; perhaps people who convene sessions or organize meetings shouldn't start out advertising their intention to publish a thematic set as a carrot to reluctant speakers. Rather, maybe the decision is better made after a successful session with the caveat that the Special Publication would be complete with extra contributions on this and that by him and her. That approach seems to have worked well here, delivered the product pretty quickly and made for a worthy and timely addition to the Special Publications series.

Rob Ellam

HUDDART, D. & GLASSER, N. F. 2002. *Quaternary of Northern England*. Geological Conservation Review Series Volume 25. xvi + 745 pp. Peterborough: Joint Nature Conservation Committee; distributed by NHBS Ltd, 2–3 Wills Road, Totnes, Devon TQ9 5XN, UK. Price £70.00 (hard covers). ISBN 1 86107 490 5.
DOI: 10.1017/S0016756805250434

Quaternary of Northern England is the latest addition to the Geological Conservation Review (GCR) Series. This series of books, 47 of which are planned, is dedicated to recording the features of interest and important conserved localities (the so-called Sites of Special Scientific Interest – SSSI) in Great Britain. The aim of this unique collection, that will eventually cover all the major geological and geomorphological topics in the British Isles, is to provide assessments of evidence from sites in a way that 'the conservation value of the sites is clear'.

This latest addition to the GCR Series is a substantial work by any standards, including 78 accounts of sites that provide the key evidence for the interpretation of the Quaternary environmental and climatic history of the region. The area covered by this volume extends from the Welsh Borderland and northern Lincolnshire in the south, north to the Scottish border. This critical region includes some of the most spectacularly attractive scenery in Britain, such as the Cheviot Hills, the Lake District, the Peak District, the Pennines and the North Yorkshire Moors, as well as the intervening lowland areas.

The volume begins with an introduction to the region's Quaternary, followed by a review of the late Cenozoic environmental evolution in which the rationale and foundation of the Quaternary record are presented. The review strictly begins with a short chapter on the pre-Quaternary, principally Tertiary sediments and weathering phenomena, evidence of which is surprisingly common in a region that has been subjected to major glaciation multiple times during the later Pleistocene.

For the same reason, direct evidence for Early and early Middle Pleistocene events in the region is very limited because it lies almost entirely within the extent of the Late-Devensian (Weichselian) glaciation. The glacial/interglacial record, reviewed and discussed in the fourth chapter, is therefore restricted by comparison to the details in later sections. However, many interesting and significant sequences are discussed, including the cave- and fissure-fills in Derbyshire, County Durham and Northumberland that in the past yielded impressive vertebrate assemblages. Later, Middle Pleistocene pre-Devensian glacial deposits are

found in Yorkshire, Derbyshire and surrounding counties and almost certainly include evidence of two major glaciations (Anglian and Wolstonian). Interglacial sediments are known from several sites including Kirmington and Speeton, whilst palaeosols and speleothems of Middle Pleistocene age have been identified from several localities.

The Upper or Late Pleistocene is far better represented, as might be expected. In particular the last interglacial or, more precisely, the Ipswichian Stage, is represented by mammalian remains in fissure-fillings, fossiliferous muds, palaeosols, cave deposits, river terrace deposits, estuarine, coastal and peat accumulations across the region. The record, although fragmentary, is very therefore diverse. Here several key localities are reviewed in detail.

However, it is in Chapter 5 that we find the real 'meat' in this volume – the Devensian glacial sequence. Following an exhaustive and informative 47-page introduction, no less than 17 key sites, features or structures are presented in detail. This standard of coverage continues into Chapter 6 on the Late-glacial where eight critical sites are discussed. Periglacial landforms and mass movement sediment sequences are the focus of the seventh chapter. Finally, the Holocene (Flandrian) landscape history, represented by 31 localities and a detailed overview, are presented in the final chapter. The book is completed by a comprehensive list of references, a glossary of terminology and botanical names used in the volume, and two indices, the first a list of fossil names and the second a general index.

Each of the localities, features or structures described is systematically presented in exhaustive and impressive detail, as we have come to expect from this series. The descriptions are beautifully illustrated with clear, helpful line drawings and sharp, appropriate monochrome photographs.

By any standards this work is a *tour de force* of which the editors and their twelve contributors should be justifiably proud. This handsome volume is an invaluable reference for all British Quaternary workers and indeed anyone who wants to be well informed about the 'earth beneath their feet' in northern England. The GCR publications series is one of the most useful and important reference resources on the regional geology of Britain, documenting the richness and diversity of our natural heritage. It is an excellent advertisement for the work of the Joint Nature Conservation Committee. We look forward to seeing the remaining 22 volumes!

P. L. Gibbard

POAG, C. W., KOEBERL, C. & REIMOLD, W. U. 2003. *The Chesapeake Bay Crater. Geology and Geophysics of a Late Eocene Submarine Impact Structure*. Impact Studies Series. xv + 522 pp. + CD-ROM. Berlin, Heidelberg, New York: Springer-Verlag. Price Euros 129.95 (+ VAT at local rate), SFr 210.00, £100.00, US $169.00 (hard covers). ISBN 3 540 40441 4.
DOI: 10.1017/S0016756805260430

This book starts with a quote from the late Derek Ager: '. . . bangs have replaced whimpers and the geological record has become much more exciting that it was thought to be.' Certainly, one of the big 'bangs' of the latter part of the Phanerozoic was the Chesapeake Bay impact, about 35 million years ago. Much has been published in scientific papers about Chesapeake Bay and its effects, starting during the early 1980s when deep-sea cores bearing a few centimetres of the crater's ejecta were recovered by the *Glomar Challenger* off Atlantic City, New Jersey. Subsequent drilling onshore followed by multi-channel seismic reflection studies by petroleum companies revealed that a concentric, roughly 90-km-diameter impact structure lay beneath the Delmarva Peninsula, Chesapeake Bay, and part of eastern Virginia. Ultimately, a geochemical link was established between the Chesapeake Bay impact and the North American tektite strewnfield.

Now comes the definitive technical book on this impact feature by three highly qualified impact researchers, C. Wylie Poag, Christian Koeberl, and Wolf Uwe Reimold. Wylie Poag was one of the original discoverers of this huge impact structure and his two co-authors are renowned researchers of impacts. It was largely through Christian Koeberl's work that the Chesapeake Bay crater–North American tektite strewnfield link was established.

The book is divided into fifteen chapters, including chapters on geological and geophysical frameworks of the impact site; the primary crater and its secondary craters; syn-impact and post-impact deposits; the age of the structure; chapters on geological consequences, biospheric effects, and residual effects of this impact; chapters on comparisons with other impact craters and with impactites of other craters; and a chapter on implications of this impact for impact models.

There is also a substantial appendix, which includes an explanation of data sources, references, an index, and a CD-ROM. The CD-ROM is most impressive and – perhaps equally important – easy to use. It contains seven maps and charts (including geophysical logs and structure maps), selected seismic reflection profiles (Chesapeake Bay and three other craters), and selected text figures in colour (most figures are black-and-white or greyscale in the printed text).

The chapters of the book devoted specifically to Chesapeake Bay are remarkable for their substantial detail. For example, there is an in-depth treatment of pre-impact and post-impact stratigraphy with pertinent illustrations (diagrams and colour core photographs). What I found especially intriguing to me as an impact researcher were the chapters presenting detailed comparisons of this structure with other impact craters, both subaerial and submarine, and comparisons between other impactite formations (i.e. within other craters) and those within Chesapeake Bay crater. I expect that the terminology of marine impactites presented in these chapters will become more widely used in the impact community, in part because of this excellent synthesis. As impact geologic research progresses, we will delve more deeply into impact effects and biotic recovery from impact. This book presents three well-written chapter discussions on these important and timely topics.

Few craters or impact structures have such thorough analyses published under one cover. The authors synthesize the results of deep core drilling, seismic reflection profiling, morphology and gravimetrics, sedimentology and petrology, geochemistry, and palaeontology in their detailed analysis of this structure. This book is a 'must have' for impact researchers and anyone else who would like a well-written and timely introduction to impact crater studies in general and Chesapeake Bay in particular. It contains carefully documented, state-of-the-art science in the realm of large marine impacts in geologic history, deserves careful study by anyone interested in impact geology and, further, it deserves a place in all good geologic libraries.

David T. King, Jr.

BUFFETAUT, E. & MAZIN, J.-M. (eds) 2003. *Evolution and Palaeobiology of Pterosaurs*. Geological Society

Special Publication no. 217. v + 347 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. ISBN 1 86239 143 2.
DOI: 10.1017/S0016756805270437

Useful volumes on pterosaurs – the flying reptiles of the Mesozoic – are few and far between, and there are only really two invaluable volumes on these fantastic animals: Harry Seeley's 1901 *Dragons of the Air* and Peter Wellnhofer's 1991 *The Encyclopedia of Pterosaurs*. Combining 21 papers authored by just about everyone in the world of pterosaur research, this new volume is therefore a significant work indeed. It can be divided into three sections: descriptions of new taxa; phylogeny and functional morphology; and palaeobiology – pretty much enough of everything in pterosaur science to make everyone happy, though there's sadly little on the history of pterosaur science or on pterosaur origins.

A few descriptions of new taxa here are long awaited, including those of the toothed *Pteranodon*-like ornithocheirid *Ludodactylus* and the high-crested tapejarid *Tapejara navigans* (this is the unnamed species featured in a BBC TV series, the name of which I forget). Maybe more could have been made of the suggestion, made in the latter paper, that tall-crested pterosaurs might have used their cranial crests as sails or rudders, but then the authors do note that this area requires further investigation. The planned name for the new Morrison Formation scaphognathine *Harpactognathus* must have been *Harpygnathus* as this name is (apparently inadvertently) used in a figure caption. Two papers provide significant new data on Triassic pterosaurs, and new large Cretaceous pterosaurs from Venezuela, Morocco and Romania are described.

Perhaps surprisingly, comprehensive phylogentic schemes for Pterosauria have remained unpublished prior to the appearance of this volume, and the inclusion here of two major works on the total phylogeny of Pterosauria is most welcome. The two studies (by Alex Kellner and David Unwin respectively) produce quite different cladograms; one problem that arises as a result is that both authors provide different phylogenetic definitions for clades with the same names.

A few of the papers here provide real eye-opening data on pterosaur morphology. Most notable among these is Frey *et al.*'s paper on pterosaur soft tissue anatomy. A new *Rhamphorhynchus* specimen preserves blood vessels, a fibre meshwork and other structures within the wing membrane, a South American azhdarchoid preserves a wing membrane that extends as far distally as the ankle, and a *Pterodactylus* specimen shows that at least some members of this genus possessed a great big soft tissue head-crest. Unfortunately the impact of this paper has been lessened by the publication of much of this data in a paper that appeared not long before this volume did.

In a thorough comparative analysis, Bennett reconstructs pterosaur pectoral musculature and, if anybody doubts that pterosaurs were pneumatic, Bonde & Christiansen's description of pneumatic foramina in the skeleton of *Rhamphorhynchus* should be compelling. Eyebrows may be raised by Bonde & Christiansen's proposal that bristle-like integumentary structures may have been shared by the common ancestor of dinosaurs and pterosaurs, but then lots of people have been thinking this. It would of course explain the quill-like structures seen in at least one ornithischian dinosaur (Mayr, Peters & Plodowski, 2002). Finally, in what has already proved to be a highly controversial proposal, Frey *et al.* argue in another paper that some pterodactyloids were 'bottom deckers' while others were 'top deckers'. Whether Frey *et al.* are right or not, the point is that large pterodactyloids exhibited surprising diversity in pectoral morphology, and presumably in flight style.

The volume ends with four papers on pterosaur tracks, which include walking, swimming and (possibly) feeding traces, and two on bone histology. Terrestrial locomotion in pterosaurs has been a hot topic lately, augmented by computer modelling. This makes the papers included here appear a bit lack-lustre, though they do get across the point that many tens of good pterosaur tracks are now known.

It is no exaggeration to describe this volume as the most significant addition to the pterosaur literture ever, and at least one paper from it will surely be cited in every post-2003 pterosaur paper, ever. It's not cheap but, if you like pterosaurs, you *must* get it.

Darren Naish

Reference

MAYR, G., PETERS, D. S. & PLODOWSKI, G. 2002. Bristle-like integumentary structures at the tail of the horned dinosaur *Psittacosaurus*. *Naturwissenschaften* **89**, 361–5.

ULMSCHNEIDER, P. 2003. *Intelligent Life in the Universe. From Common Origins to the Future of Humanity*. Advances in Astrobiology and Biogeophysics Series. x + 251 pp. Berlin, Heidelberg, New York: Springer-Verlag. Price Euros 69.95 (+ VAT at local rate), SFr 123.50, £54.00, US $69.95 (hard covers). ISBN 3 540 43988 9.
DOI: 10.1017/S0016756805280433

The last few years have seen the throwing open of a whole series of remarkable new windows into our cosmic habitat, be it the stunning pictures from Mars, the extraordinary images of the snowball moon Europa, or much further afield a continuing stream of discoveries of new extra-solar planetary systems. Before too long, if all goes to plan, we have the promise of new insights into Titan and somewhat later the first proper investigation into a comet with the Rosetta mission of the European Space Agency. These are, of course, early days and many surprises surely await us, but from what we already know the search for extra-terrestrial life has a new impetus. It is hardly surprising that the area of astrobiology already has two mainstream journals and a steady series of textbooks ranging from introductory to highly specialist. It is to this latter genre, pleasingly situated in the mid-range of technical but understandable, that we welcome Peter Ulmschneider's intelligent and succinct contribution. The chief virtue of this book is both its extraordinary range and the clarity of exposition. Ranging from star formation to the genetic code and the probabilities of extra-terrestrial civilizations Ulmschneider writes with flair and assurance, and were it not for its rather steep price this would be a good text for a short course in astrobiology.

Against received wisdom, but along lines that I very much agree with, Ulmschneider suggests that the emergence of something like a humanoid is a near evolutionary inevitability. There are, however, several areas where the critic can point to areas of more legitimate controversy. One revolves around the question of the origin of life. Here Ulmschneider provides a crisp summary, not least in his graphic description of the chemistry-laboratory of the early

Earth, a place as he writes that was 'very dusty, hot, and chemically aggressive [with] desiccating lakes, evaporating lagoons, hot springs, and oceanic fumaroles with hot acidic effluence, as well as energetic UV radiation' (p. 101). Yet, Ulmschneider also shows an optimism as to the likelihood of our understanding the origin of life which to put mildly is not really consistent with the last fifty years of endeavour.

The target of the book is the question of the evolutionary inevitability of intelligence and our search for its extra-terrestrial equivalence. Ulmschneider even considers UFOs and, whilst properly sceptical as to the available evidence, reminds us of the importance of keeping an open mind. There is also a careful discussion of the famous Drake Equation, which aims to estimate the number of extra-terrestrial civilizations. Here, too, Ulmschneider is quite optimistic as to the likely number in our galaxy alone, although he reminds us that the great majority might be extinct. As to why we have not been contacted he adopts the zoo (not larder!) hypothesis that we may well be under observation, but any direct contact to us would be immensely destructive. Yet Ulmschneider also regards humans as being on the threshold of an extraordinary new set of adventures. Colonies in space, for example, might lead to an effloresence of cultural diversity, although given the power of the state and commercial monopolies one might take a slightly more cautious view of the degree of freedom and diversity that would be regarded as 'suitable'. Nevertheless, such enterprises might still be essential given that our future on Earth is more precarious than we probably care to admit, be it by the agency of social chaos, political megalomania or episodes of volcanic super-eruptions or bolide impact.

There is, however, another aspect of human destiny that might raise eyebrows. Ulmschneider is enthusiastic as to the biological revolution already underway. In his view the decoding of the human genome will 'provide us with . . . a certain finite stretch of the DNA [that] will tell us how *a self-conscious thinking brain is constructed*' (p. 191, his emphasis). I am not sure things will be quite so straightforward. Yet, as Ulmschneider also emphasizes, the potential for such understanding opens the portals for modification. However, when he writes of 'descendants [*sic*] who would far surpass us in mental capabilities and power, and would then take over the leadership in all fields of mankind' (p. 191) at least in this English brain alarm bells begin to ring. Indeed, there is a certain ambiguity in Ulmschneider's stance in as much as he fully realizes that the worrying trends in human irrationality, those 'dark forces [that might] turn out to be unmanageable' (p. 204), might necessitate a change in the hardware, that is 'to modify our brains to achieve a more stable responsible society' (p. 204). Perhaps the readers of *Geological Magazine* are so glad they are all alphas? Is this just being Luddite, a fear of the future? If the emergence of intelligence is inevitable, and subject to the laws of nature, perhaps, as Ulmschneider writes, just as 'it would be wrong to prevent a child from growing up and to forbid it to realize its natural destiny, so it would be *wrong* to halt the evolutionary development of mankind' (p. 193, my emphasis). Yet, this view begs a whole series of questions, not least the conflation of a possible physical law to an ethical principle. So too, in extrapolating present human trends in cognitive ability to how a much more advanced extraterrestrial might be, his thought that they 'must be essentially God-like, with faculties that border on omniscience and omnipotence' (p. 209) might again give us pause for thought.

Peter Ulmschneider is quite right to raise these points, even though one might wish to differ in terms of ethical perspective. Nevertheless, as with all other areas of science, the nascent field of astrobiology might actually be leading us to a Pandora's box of surprises. Whether or not one shares Ulmschneider's optimistic view of our future and place in the cosmic realm, he is to be congratulated both on producing an excellent synthesis but also touching on potential philosophial and ethical points which may well assume a degree of urgency sooner than any of us expected.

Simon Conway Morris

PALMER, D. 2003. *Fossil Revolution. The Finds that Changed our View of the Past*. 144 pp. London: HarperCollins Publishers. Price £16.99 (hard covers). ISBN 0 00 71 1828 7.
DOI: 10.1017/S001675680529043X

In this book Palmer takes the reader on a journey through historical time, exploring the history of the study of fossils, and highlights the major breakthroughs and discoveries which have shaped the science of palaeontology. It is a story of changing perception and also of changing methodology, of spectacular new finds that have changed our understanding of evolution.

Palmer takes us through the history of palaeontological endeavours from the very earliest apparent recognition of fossils by pre-humans, the discovery of many classic fossil sites (including the obligatory romp through the Burgess Shale) right up to the as yet fruitless search for ancient DNA in amber and the fine discoveries of apparently Precambrian embryos. The chronological nature of the book allows the reader in the space of a few hours to get to grips with the evolution of thought that has taken thousands of years. Doug Palmer is a well known science writer, having written a number of books intended to further public understanding in the earth sciences and many articles for non-specialists in science magazines. As a result he is excellently placed to write this book.

The history of science seems to be enjoying a popular resurgence and there seems to be a particular interest in geology. As a result some of the stories which unfold here, for example the roles of Mary Anning, William Smith, Sir Richard Owen, Gideon Mantell and Arthur Holmes, have been extensively raked through recently and at greater length by other authors. There are no new insights in these stories, but to have left such essential episodes out would have been curious to say the least. Mercifully, Palmer spares us the apocryphal tale of Walcott's horse discovering the Burgess Shale and other 'classic' stories. The real prizes in this book are the less well rehearsed stories. An example of one of these is in the first chapter where Palmer argues that the very earliest humans and even possibly Neanderthals and *Homo erectus* recognized fossils and valued them aesthetically, although they did not appreciate them for what they were. He illustrates this with a beautiful flint hand axe, perhaps as much as 200 000 years old, from Norfolk, which bears a well preserved pectinoid bivalve bang slap in its centre – surely not an accident? – and the inclusion of at least subfossil shells in Neanderthal burials.

The book is beautifully and authoritatively written and there can be few quibbles here. It has an easy lively style. Although, in a rare lapse of concentration, Palmers demotes the invertebrates from their animal status when, on page 35, we are told that not all mosasaurs were predators, some of them ate clams and other shellfish! The book is illustrated copiously if not beautifully by reproductions of original

plates and maps as well as new photographs. The use of copies of original plates gives the reader a real feeling of historical authenticity, although the density of them makes the book rather drab in comparison with other books. Certainly many of them might have been more aesthetically pleasing if they had been reproduced at a larger size. Some of the modern pictures, however, are rather poor. For example, the picture of the cliffs at Lyme Regis on page 37 looks particularly uninviting, certainly much less so than in real life! The illustrations give the book a certain 'olde worlde' look which is emphasized by the title fonts.

Some of the tales may be well known but they are wonderful and of course everyone has to discover them somewhere for the first time. This well written book is a good place to come across them in chronological order and even for the most well read to meet a few less well known tales. Every professional palaeontologist should know how the science evolved and what factors, social, economic, technological and pure chance, have shaped our understanding of evolution. The story goes on.

Liz Harper

CURRIE, P. J., KOPPELHUS, E. B., SHUGAR, M. A. & WRIGHT, J. L. (eds) 2004. *Feathered Dragons. Studies on the Transition from Dinosaurs to Birds.* xiii + 361 pp. Bloomington: Indiana University Press. Price US $49.95 (hard covers). ISBN 0 253 34373 9.
DOI: 10.1017/S0016756805300434

Indiana University Press have, over the past few years, been generating a series of books (mostly as edited multi-author volumes) under the general theme of 'Life of the Past'. This book is one of the latest in the series, and claims to represent the proceedings of a meeting held in Florida in 2000 to discuss the evidence and controversies surrounding the issue of bird origins and their relationship with dinosaurs (and also to publicize the then recent discovery of a new, small, bird-like dinosaur nicknamed 'Bambiraptor'). In such a relatively fast-moving field (as a direct consequence of new discoveries made since the time of that meeting) this book is already creaking a little with age – but it does presumably represent a snap-shot of the general debate and reflects to some extent the pace of change or intellectual development within this field of interest. It is, as the editors point out, certainly a theme that has captured the public imagination in recent years whether indirectly through the appearance of the *Jurassic Park* trilogy, or the well-publicized fracas concerning the authenticity (or otherwise) of the Piltdown-esque *Archaeoraptor*.

The book comprises an Introduction and 14 chapters by numerous luminaries, and these are themselves split into three sections: 'The Setting', 'Osteology and Ichnology' and 'Eggs, Nests, Feathers, and Flight'. The introduction by R. T. Bakker (a noted visionary and simultaneously quirky controversialist) sets the scene rather well by revisiting the work of Edward Hitchcock, who amassed a great collection of three-toed footprints from rocks of Triassic and Jurassic age primarily from the Connecticut Valley. The footprints, which are still preserved at Amherst College, were named *Ornithichnites* (quite literally, petrified bird footprints) and described in considerable detail by Hitchcock who, as long ago as the 1830s, became convinced that the three-toed impressions had been made by gigantic bird-like creatures (echoing Pliny Moody's discovery of the tracks of Noah's Raven a few years earlier in the same area). The detailed analysis of these prints carried out and published by Hitchcock is a testament to his considerable skill as an observer and rational thinker who, as Bakker points out with a flourish, is a lesson to us all. Many of Hitchcock's avian comparisons have borne the test of time remarkably well, especially given the rash of new 'dinobird' discoveries in recent years.

As a 'gauntlet' for the remainder of the book this article is well chosen. Sadly I have to say that the remainder of the book does not rise to the challenge as well as it might have. For example the first section 'Settings' comprises two articles: one by Dale Russell offers a compilation of Asian environmental indicators which begs far more questions than is actually comfortable; in contrast Greg Retallack provides a very competent overview of the geochemical and biological indicators of the role of acid rain in the K/T extinction event, but rather skirts around issues relating to the survival of birds as opposed to non-avian dinosaurs.

'Osteology and Ichnology' contains a long article describing the anatomy of the 'new' theropod which is, to my possibly deeply cynical mind, given the appallingly Hollywood-inspired formal scientific name of *Bambiraptor*; this article would have been more appropriately directed at a peer-reviewed journal. This paper is followed by a short note on another new dromaeosaur (*Atrociraptor*) and an interesting short note on the braincase of the much better known *Velociraptor*. Then there is, for my palate, a tiny nugget – a short squib describing a theropod sternal plate (chest bone), that immediately rang recognition bells for me! The specimen described looks suspiciously similar to a bone from Transylvania that has been bothering me for ages – at last, a possible answer! It's one of those 'left-field' bits of information that we all yearn for (thank you Stephen Godfrey and Phil Currie). There are also short pieces devoted to the detailed analysis of individual pelvic bones (Fernando Novas) and an overview of dino-bird tracks by Jo Wright (in a sense revisiting Hitchcock with 20 × 20 hindsight).

Then slap in the middle of Jo Wright's paper we find a colour 'supplement' with some relatively important anatomical photographs, and some totally unimportant paintings/sketches of dinobirds or palaeobiologically inspired scenes. This is an oft-repeated quirk of this series of IUP books and I do not wholly approve: it smacks of 'coffee-table' in a book that is clearly not of that ilk . . . or is it?

The final section draws together a number of articles that emphasize bird-like biology in theropod dinosaurs: eggs, implied nesting behaviour and physiology linked to brooding; the biological significance of feathers (brooding *v.* flight); the link between feathers and the origin of flight and the general architecture of feathers – all review topics that have been covered in various ways in recent years with differing degrees of confidence/success. Worst of all (for me) this section ends with a chapter that attempts some dinosaurian forensic pathology in the hands of R. T. Bakker (who opened the book with some gusto) and Gary Bir, under the title 'Dinosaur Crime Scene Investigations'. Suffice it to say that I do not think that this type of essay should have been published in a book that has the 'air' of scientific authority to convey an impression of what dinosaur palaeontologists do, and how they think.

This book is for me most definitely a 'curate's egg'. I really had to search for the worthwhile bits. On balance I do not think it does the job that is intended (and I am far from clear what that job might have been). This is not 'state of the art' or anything remotely close (and those that have put useful work into this book might regret doing so). The articles are simply too varied in their approach and tone and some are simply inappropriate in this sort of format. I really wonder

who buys these books and what precisely they get from it. I am of course willing to receive a review copy (not many people I know actually refuse books when they are offered *gratis*) but, sadly, I would not pay for this and I find it difficult to recommend others to do so. Mind you, knowing my track record a pound to a penny says that this will be one of the best sellers in IUPs entire 'Life of the Past' series!

David Norman

BUSSEY, B. & SPUDIS, P. 2004. *The Clementine Atlas of the Moon.* Iii + 316 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £50.00, US £80.00 (hard covers). ISBN 0 521 81528 2.
DOI: 10.1017/S0016756805310430

Many maps and atlases of the Moon have been produced over the centuries. Two are mentioned here for comparison with the one under review. The first is the *Consolidated Lunar Atlas* (1967) which is unique, first because all the telescopic plates are hand-printed to a superb standard, and second because each area of the Moon is shown at a range of sun angles. Only a limited number of copies were produced and it has now become a collector's item; it is still of value in lunar research and the plates are available on the internet. The second is *The Times Atlas of the Moon* (1969) which brings together a set of airbrush maps, originally prepared by the US Air Force. This book, useful in its time, is now out of print, and it is this atlas that the *Clementine Atlas* seeks to up-date and replace.

The Clementine Atlas of the Moon has significant differences from previous ones not least in that it covers the whole globe at the same scale, rather than just the near side. The Moon is divided into 144 map areas and two maps are presented on facing pages for each area. One is an airbrush map taken from map-sheets prepared by the US Geological Survey. All feature names are printed on them. The facing, and complementary, map is an image of the same area on the same projection obtained by the ultraviolet–visual camera on the US Department of Defence/NASA Clementine Mission in 1994.

Included is a comprehensive up-to-date gazetteer, as well as a short description of the Moon and the history of exploration. There are also global maps in colour showing topography determined by laser ranging, iron and titanium abundances of surface rocks, false colour composite showing small colour variations of the Moon's surface, and true colour (all based on Clementine data); and thorium abundance and surface neutron flux (from Lunar Prospector data), together with a geological map.

This splendid book is timely in view of the growing interest in stepping up exploration of the Moon, and will stand as a landmark publication in lunar studies. A 'must' for all those interested in the Earth's satellite.

John E. Guest

Reference

LEWIS, H. A. G. (ed.) 1969. *The Times Atlas of the Moon.* Times Newspapers Limited Printing House.

KUIPER, G. P., WHITAKER, E. A., STROM, R. G., FOUNTAIN, J. W. & LARSON, S. M. (eds) 1967. *Consolidated Lunar Atlas*. University of Arizona: Lunar and Planetary Laboratory.

GLUYAS, J. G. & HICHENS, H. M. (eds) 2003. *United Kingdom Oil and Gas Fields. Commemorative Millennium Volume.* Geological Society Memoir no. 20. vii + 1006 pp. London, Bath: Geological Society of London. Price £175.00, US $293.00; GSL/IGI members' price £100.00, US $167.00; AAPG/SEPM/GSA/RAS members' price £105.00, US $175.00 (hard covers). ISBN 1 86239 089 4.
DOI: 10.1017/S0016756805320437

As a society, we have not had much experience of celebrating millennium boundaries. A thousand years ago, most people were too busy with the problems of surviving to mark the event in any special way, so this time round we had to make it up from scratch. A few ideas, like planting forests, had obvious merit, while others, like the wobbly bridge, have now been fixed and found their way into public affection. Some like the large tent in east London just look plain daft. So when we receive a bit of millennium commemoration four years after the event (or three if you are a pedant), we are entitled to ask whether we have a valuable asset for the future or a flash exterior filled with vapid platitudes.

The exterior is certainly impressive, with the 1016 pages beautifully bound, very high quality printing on good paper, well up to the standard that we have come to expect from the Geological Society Publishing House. The idea of this book is not new: Memoir 14 (published in 1991) set out to give an account of all of the UK's oil and gas fields to commemorate the twenty-fifth anniversary of first North Sea oil. One of the main arguments for this update is that much has changed in the last decade – more fields on production, better data and a longer perspective on the production history. Like its predecessor, this volume tries to provide information in a common format.

The editors are both experienced petroleum geologists, who have worked hard to ensure an even standard of treatment. Fields are described individually, but grouped into eight regions: starting in the East Irish Sea and working clockwise around the north of Britain through the Atlantic Margin, the Viking Graben, Moray Firth, Central Graben, the Southern North Sea, East Midland Basin, to finish in the Weald and Wessex Basin. Within each region, fields are in alphabetical order, which makes for some strange bedfellows; for instance, the supergiant Forties field (> 2 billion barrels) is immediately preceded by the Flora field (13 million barrels). Most papers deal with a single field, although a few cover groups of closely related fields (e.g. the Hamilton and Hamilton North fields, or the T Block fields). One paper, by Trueman, describes ten fields in the Weald Basin, headed by Humbly Grove, and prompting me to wonder why it deserved its place at the head of this non-alphabetical list.

Gluyas & Hichens have succeeded in assembling an impressive list of contributors; there are 71 chapters discussing 114 separate oil or gas accumulations. Where I have knowledge, the chapters are all written by geologists or geophysicists with recent experience of the fields that they describe. All authors were working to the same brief with a constant format: history of the field, structure, stratigraphy, trap, reservoir, source, reserves and production history. There are some variants on the format (probably due to commercial constraints), but the great majority of authors have stuck fairly closely to the plan. Some of the variation could have been smoothed out by a combination of more brutal editing of some papers, coupled with a plea for more information elsewhere. Contrast, for instance, the description of North Cormorant (11 pages) with Forties (a fairly terse five pages). Both are good sources of information, but they look

unbalanced. However, this should not obscure the editors' achievement: they have produced a book which allows us to make comparisons between fields of the same type, for instance between the well-known Brent field and the much smaller, much less well-known Don field, which together represent the extreme end members of variation in the Brent Province.

The value of this memoir as a resource cannot be overstated – the information it contains represents billions of pounds of data acquisition, making the £175 price tag look pretty modest. The use of the book as a data source means that few purchasers will buy it to read, which is a pity, because the thing that rings out from a thorough read is the sheer variability of the petroleum geology in the UK, probably more than in any other oil province. This point is brought out in the introductory chapters where Richard Hardman reviews the history of the industry, concentrating on the development of different plays and examining the generic lessons, and John Underhill discusses the tectonic and stratigraphic framework of the UK oil and gas accumulations. This history and technical variety of the UK domestic oil industry means that many of the scientific and technical innovations which have revolutionized the industry over the past few decades have originated here.

Inevitably in a work of this ambitious scope, there will be problems. In my view they are sins of omission, which were probably beyond the editors' power to influence. None the less, there are some well-known names missing. I would have liked to see chapters on: Ardmore (formerly Argyll), the first abandoned field to be re-licensed; Beatrice, the great tease of the Inner Moray Firth, and one of the few oil fields with a non-Kimmeridgian source; Clair, admittedly not in production, but the largest UK field in area, and the greatest technical challenge facing us; Magnus, one of the great production geology success stories; and Wytch Farm, our biggest onshore field, However, the absence of a few friends should not stop us going to the party, so I would urge people to buy this excellent book. It is a worthy celebration of the millennium, and is not even vaguely Dome-shaped.

David Macdonald

BALDRIDGE, W. S. 2004. *Geology of the American Southwest. A Journey through Two Billion Years of Plate-Tectonic History*. xvi + 280 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £55.00, US $70.00 (hard covers), £19.95, US $24.00 (paperback). ISBN 0 521 81639 4; 0 521 01666 5 (pb).
DOI: 10.1017/S0016756805330433

Many geologists, heading for work or holiday in a new part of the world, will look for a concise, informative overview of that region's geological history. Frustratingly, the availability of such reviews, in the journals or in a book, does not always correlate with the geological fame of the region. So, in several visits to the incomparable Permian reef belt of west Texas and New Mexico, I have failed to find a book that reliably summarizes the complete geological history of this dry southwest corner of the USA. This is all the more surprising because the region includes that most celebrated of geological exposures, the Grand Canyon. Scott Baldridge has therefore done us all a service in producing a compact, readable and well illustrated guide to an area that attracts many geological tourists.

The area described is centred on Arizona and New Mexico, taking in small parts of Utah and Colorado to the north, Texas to the southeast, Mexico to the south, and California to the west. Physiographically, the area comprises the southern Colorado Plateau and Basin and Range together with the southern tip of the Rocky Mountains. This is an area of arid grandeur, with units from most parts of the past two billion years of earth history beautifully exposed and therefore well researched. The resulting wealth of the literature on such an area presents a dilemma: should it be summarized in detail, so that only trained geologists will understand, or should it be simplified for the non-geologist, leaving the more expert readership unsatisfied? Scott Baldridge has leaned towards a more detailed treatment, about the level of a second-year undergraduate textbook. This will suit readers of *Geological Magazine*, though I doubt that the average visitor to the region, referred to on the back cover as a potential purchaser, will do more than look at the pictures.

Baldridge's text leads us logically through the very full geological history of the Southwest, first documenting the main rock units and then diagnosing their formation mechanisms and tectonic setting. He draws out well some general concepts that have been developed in the region, such as terrane tectonics, sequence stratigraphy, core complexes and lithospheric flexure. His style is workmanlike rather than elegant, but the plot moves along briskly, unburdened by superfluous detail. I particularly enjoyed the clear analysis of the Proterozoic geology, something easily ignored by those of us pre-occupied with riches higher in the column. The book is well illustrated with line drawings and with field photographs, some of which are provided both in black-and-white and in a separate colour section. I would have liked to see more purpose-drawn cartoons of some of the complex plate-tectonic settings that have operated in the region: the author perhaps relied too much on using what was available from other publications.

Geology of the American Southwest is neither a detailed stratigraphic reference nor an exposure-specific field guide: you will still need these for planning a serious field trip to Southwest USA. However, this is an informative and entertaining book to buy the next time you take the family to see Carlsbad Caverns, Monument Valley or the Grand Canyon, or they take you to Phoenix or Las Vegas.

Nigel Woodcock

LAMB, S. 2004. *Devil in the Mountain. A Search for the Origin of the Andes*. xi + 335 pp. Princeton, Oxford: Princeton University Press. Price £19.95 (hard covers). ISBN 0 691 11596 6.
DOI: 10.1017/S001675680534043X

Simon Lamb weaves three themes into this book. He describes a decade of field-based and analytical work in the Bolivian Andes, and uses his experiences as the springboard to explain how mountain ranges form. This is at a level pitched at non-geologists. In amongst the science are descriptions of Bolivia, especially the trials of working in harsh Andean terrain.

The first two aims are certainly met successfully, and I recommend this book as an introduction to continental tectonics for non-geologists, especially those who want to get an insight into how a scientist develops ideas over the years. Moments of jubilation and revelation are balanced by times of doubt, anxieties over funding and the disappointment of being beaten into press by rival groups. Lamb is very candid about the times when he and colleagues found themselves on the right lines, but behind another research team in getting the

paper published. If anything, he is too modest about the publication record his group has achieved, and does not get across how regular publications are such a necessity for academic geologists.

The layout of the book has passages describing the progress of Lamb's own research, interleaved with descriptions of the nature of the continental crust and the processes that could create major ranges such as the Andes. The treatment of the tectonics is partly historical. Airy & Platt's models of crustal structure and Peach & Horne's work on thrust belts are covered in early sections, whereas plate tectonics comes in late in the book. I think this works well, although it is hard for me to judge how a layman would find the level of the text.

Because his research has used so many different approaches, Lamb manages to include examples of techniques as varied as palaeomagnetism and helium isotope determinations. This is a very valuable insight into how continental tectonics is best understood by the integration of many techniques, rather than the pursuit of any single one. Likewise, the book is permeated with the role of fieldwork as an essential part of tectonic research, be it sampling volcanic gases from 5000 m high volcanoes, or observing the geomorphology of plateau uplift in the Altiplano. Perhaps this role for fieldwork needs more outspoken support in the text; non-geologists may not realise that Lamb is an increasing rarity in his multi-disciplinary and field-based approach.

The descriptions of Bolivian life and culture are rather patchy, and lack the neat progression given to the research and tectonics. They add some colour to the book, but anyone reading for a description of Bolivia itself would be disappointed. Bolivian geologists are present at the start, but rapidly fade from view.

Overall, the book would make a great gift from a geologist to a friend, colleague or family member interested in knowing something about tectonics and the life and work of a tectonic geologist.

Mark Allen

UPTON, B. 2004. *Volcanoes and the Making of Scotland.* viii + 247 pp. Edinburgh: Dunedin Academic Press. Price £16.95 (hard covers). ISBN 1 903765 40 4.
DOI: 10.1017/S0016756805350436

Volcanoes are an ideal subject for geological books aimed at the general reader. With their magnificent topographical edifices and the dramatic stories associated with their formation and eruptive processes they can lend themselves to well illustrated, interesting and informative texts.

Brian Upton's idea of telling the story of Scotland's volcanoes within the wider context of its geological history is a good one. As he says, 'many a heather-covered hillside is a gravestone to a once awe-inspiring volcano'. Volcanoes, their rock products and their remnants have figured significantly in the landscape iconography of Scotland and, thanks to such well known features as Glen Coe, Arthur's Seat in Edinburgh and the columnar jointed basalts of the island of Staffa off the west coast, are virtually part of the culture as they have been celebrated in countless poems, pictures and music.

For such a relatively small geographical area Scotland is packed with a wonderful array of rocks including many suites of volcanic rocks as part of a wonderfully complex geological history. The overall geological history has been well served by recent books such as the 4th edition of *The Geology of Scotland* (Trewin, 2002) and yet volcanoes, even ancient ones, do lend themselves to a separate treatment as in Upton's well written and useful *Volcanoes and the Making of Scotland.*

To provide any coherent story about past volcanoes for the layperson, it is necessary, as Upton does, to give a general introduction about volcanism. Then Upton sensibly chooses to tell his story starting with the best preserved and inevitably most recent volcanic episode and work backwards through geological time. Luckily, the Scottish rock record preserves a good if spasmodic history of volcanism from the early Tertiary (or rather the Paleogene as we should perhaps call it) back to the Old Red Sandstone (sorry, early Devonian) and then beyond that through the Highland Border Complex into the deeper recesses of the Precambrian and the Scourie dyke swarm some 2400–2000 million years ago and so Palaeoproterozoic or even Siderian–Orosirian if you like. It is by no means all igneous petrology for the layperson but also includes the interaction of volcanism with the past landscapes, environments of deposition and life.

Having been a lecturer in igneous petrology at Edinburgh University from 1966 until retirement in 1999, Brian Upton is very well qualified to tell this particular story. His personal research over the years has included a considerable number of these Scottish volcanic rocks and so he can write accurately about them from direct personal experience. Each section is illustrated with colour photos, maps and diagrams (there is also a short bibliography and index) and overall the book would provide a good introduction to first-year degree students as well as amateur geologists and anyone interested in the evolution of the Scottish landscape.

Douglas Palmer

Reference

TREWIN, N. H. (ed.) 2002. *The Geology of Scotland,* 4th ed. Geological Society of London, 576 pp.

BEST, M. G. 2003. *Igneous and Metamorphic Petrology*, 2nd ed. xxi + 729 pp. Oxford Blackwell Science. Price £34.50 (paperback). ISBN 1 405 10588 7.
DOI: 10.1017/S0016756805360432

Having used the first edition of Best as an excellent petrology text to teach with for about the last ten years, I was very keen to see how this new edition compares. First it comes in softback to keep the price down, but I might have preferred hardback for durability. The chapter contents are similar to the first edition, but the materials, examples and references have all been substantially updated and improved. The organisation is still systematic, but those familiar with the first edition will find some chunks now placed in different sections.

A major strength of this textbook is its appeal to readers of different levels, and its stimulating incorporation of brief explanatory text blocks, summaries and self-assessments. First and foremost it is a first-class teaching text, for the two major hardrock areas in geology (igneous and metamorphic petrology). Teachers will continue to find this second edition capable of delivering a wealth of in-depth material, comprehensively illustrated from basic concepts all the way to current research. There is a thinner igneous-only version (Best & Christiansen, 2000), but that false economy lacks the important class of high-T komatiites, which are duly treated here in their association with greenstone belts under Precambrian rock associations.

The text is underpinned by an excellent treatment of essential physics, and chemistry from microscopic-scale thermodynamics, kinetics, crystal–melt equilibria to macroscopic-scale magma dynamics, and planetary-scale petrotectonic associations. The geochemistry component has been uprated, and there is little to fault in this massive textbook (around 750 pages). I would perhaps have liked to see a little more on impact geology, which in many ways would fit the dual purpose of this book. A picture of impressive pseudotachylite from the Sudbury impact structure is incorporated, but its absence from the text suggests a new petrological opportunity missed. None the less, this second edition firmly re-establishes itself as the outstanding petrological reference and fabulous core teaching text with flair and depth to appeal to a very wide range of earth and planetary scientists, and is very highly recommended.

A. P. Jones

Reference

BEST, M. G. & CHRISTIANSEN, E. H. 2000. *Igneous Petrology*. Oxford: Blackwell Publishing. 480 pp.

MCSWEEN, H. Y., JR, RICHARDSON, S. M. & UHLE, M. E. 2003. *Geochemistry. Pathways and Processes*, 2nd ed. xvi + 363 pp. New York: Columbia University Press. Price US $89.00, £61.50 (hard covers). ISBN 0 231 12440 6.
DOI: 10.1017/S0016756805370439

The authors state in the preface that 'Our book is about chemistry, written expressly for geologists'. A nice turn of phrase in the introductory chapter will be reassuring for most geology students though – studying the Earth with 'the tools of chemistry'. This neatly puts the emphasis exactly where it should be, on what we discover about Earth systems rather than on chemistry for its own sake. The book is true to its word thereafter and includes a plethora of worked examples demonstrating the practical applications of the chemistry discussed. It is infused with the underlying maths, which often includes the derivation of important equations. The scope of the book is considerable, including chapters on organic geochemistry and cosmochemistry as well as the normal core topics. The downside of this approach is depth of coverage of course, evident perhaps in the chapters on isotope geochemistry in particular. However, it's just impossible to be completely comprehensive now and many excellent texts on various aspects of isotope geochemistry already exist, and are cited herein.

Chapter One, 'Introducing Concepts in Geochemical Systems', outlines the history of geochemistry and the breadth of the modern subject, and sets the tone for the rest of the book by identifying thermodynamics and kinetics as complementary approaches and highlighting the importance of quantitation. Chapter Two takes a look at some fundamental chemistry, and I particularly liked the treatment of bonding which emphasizes similarities and overlaps between metallic, ionic and covalent varieties rather than the differences between them. It is then much easier to understand that real molecules and minerals cannot always be pigeonholed into one or another type. This is typical of the book – a touch more detail than is normal, carefully presented to facilitate understanding.

Chapter Three takes the plunge into basic thermodynamics, with many worked problems to illustrate and reinforce the presentation. Chapter Four effectively demonstrates the complexity of geological materials, by dealing with what they invariably are – solutions of one form or another. It introduces ideal and non-ideal behaviour, fugacity and activity, and demonstrates how to incorporate contributions from mixing of end-members into reaction calculations. Chapter Five investigates diagenesis from a kinetic point of view, discussing diffusion and advection, dissolution and precipitation, resulting in a general equation for the rate of change in concentration of any species. Chapter Six represents a change in tack, being a very readable short introduction to organic geochemistry. It covers the global carbon cycle, primary oceanic production, organic matter degradation and preservation, the biological precursor compounds, biomarkers and palaeoenvironmental reconstructions. It seems to me to be a little isolated from the rest of the book in style as well as content, but perhaps this is inevitable given the traditional gulf between organic and inorganic brethren.

Chapter Seven talks about chemical weathering, using the solubilities of silica, magnesian silicates and aluminosilicates as examples. Agents of weathering – CO_2 and organic acids – are introduced and redox reactions are treated in some theoretical detail. In a final look at surface processes, Chapter Eight considers the oceans and atmosphere as an evolving geochemical system. Present bulk compositions and element distributions are outlined, followed by a detailed investigation of carbonate chemistry. Global mass balance, steady states and box models are described, and the chapter concludes with a section on changing atmosphere composition over geological time. In Chapter Nine thermodynamics is dealt with explicitly again, but now in the context of changing pressures and temperatures. The Clapeyron equation, Raoult's and Henry's laws are introduced and the practical application, thermobarometry, is the subject of worked examples at the end of the chapter. Phase diagrams come in Chapter Ten, which offers a very clear explanation of their construction from G–X plots. Binary systems are dealt with in some detail, and the complexities of three components introduced. The kinetics of crystallization form the subject of Chapter Eleven, with sections on diffusion, nucleation in melts and solids, crystal growth and rate-limiting steps.

A spectacular change of scale then takes us to Chapter Twelve, 'The Solid Earth as a Geochemical System'. The compositions of the crust, mantle and core are presented, before a discussion of fluxes and cycling between them. Mantle melting is considered in some detail, followed by magmatic differentiation by various mechanisms, and the constraints offered by trace elements. Crustal and mantle fluids conclude. The next two chapters deal with isotope geochemistry, first stable then radiogenic. These are both good outlines of burgeoning subjects, concentrating on thermometry, surface and hydrothermal processes for the former, and geochronology for the latter, which also has short sections on solid Earth tracers, the isotopic composition of the oceans and on noble gas constraints on mantle degassing. The final chapter is devoted to cosmochemistry, and is a succinct account of geochemical constraints on early planetary history. It starts with nucleosynthesis and cosmic element abundances, discusses chondrites, condensation and accretion hypotheses, nearby supernovae, extraterrestrial organic matter and ices, timescales and the bulk compositions of the terrestrial planets. Throughout the book there is careful reference to selected literature and the three appendices – maths, sources of data and useful numbers – are helpful.

I would happily recommend this book as a wide-ranging introduction to the subject. It is most suitable for advanced

students – motivated third year undergraduates and new postgraduates for example – and my copy will certainly be heavily used.

Mike Fowler

MITCHELL, W. I. (ed.) *The Geology of Northern Ireland. Our Natural Foundation*, 2nd ed. x + 318 pp. Belfast: Geological Survey of Northern Ireland. Price £10.00 (paperback). ISBN 0 85272 454 3.
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The geological history of Ireland and the British Isles and how they were cobbled together over geological time from bits of North Africa and North America is a remarkable one and one that is well known to any academic geologist. However, it has barely seeped into the collective consciousness of even the best educated youth – ask anyone faced with first-year university intakes for geology modules. And yet there is a remarkable dearth of well-illustrated accounts of this geological story for first-year students or anyone wanting to go a bit beyond the TV Titchmarsh version.

Now however an excellent account has appeared from an unlikely source. The Geological Survey of Northern Ireland has somehow found the money to produce the lavishly illustrated *The Geology of Northern Ireland: Our Natural Foundation*, a completely revamped version of a 1972 publication. Although nominally just Northern Ireland's bit of the overall story, geology does not recognize our rather pathetic cultural and political divisions and historical boundaries, and so inevitably the geological account has to cover much more than the 0.000001 % of the Earth's land encompassed within Northern Ireland.

Although multiauthored and full of local detail, nevertheless it provides an excellent introduction to the geology of Ireland and the British Isles from the Precambrian to the Quaternary plus additional useful chapters on geophysics, hydrogeology, economic resources (minerals and oil and gas) and finally geohazards. Each chapter is fully referenced and at 318 pages for £10 this has to be the geological bargain of the year. Buy several copies for the library because they will tend to be permanently borrowed. It is only a pity that the two Irish geological surveys could not have collaborated and extended the book that much further to encompass that much more of a sample of the rock record that is present in the country as a whole. And, if only the British Geolgical Survey could produce a complementary volume of similar quality and price for students and anyone whose attention span extends beyond that which TV allows for. Anyway, never mind the 'ifs', the Geological Survey of Northern Ireland is to be congratulated for what it has achieved in this volume.

Douglas Palmer

ALSOP, G. I., HOLDSWORTH, R. E., MCCAFFREY, K. J. W. & HAND, M. (eds) 2004. *Flow Processes in Faults and Shear Zones.* Geological Society Special Publication no. 224. vii + 379 pp. London, Bath: Geological Society of London. Price £85.00, US $142.00; GSL/IGI members' price £42.50, US $71.00; AAPG/SEPM/GSA/RAS members' price £51.00, US $85.00 (hard covers). ISBN 1 86239 153 X.
DOI: 10.1017/S0016756805390431

This book brings together 22 papers that collectively provide an overview of processes in shear zones. For anyone working on shear zones in the middle or lower crust or mantle this is an excellent resource, containing a wide variety of research, and demonstrating techniques on scales from microfabric studies to regional analysis using GIS technology. However, the emphasis of the papers is very much on ductile shear zones rather than brittle faults. Also, the flow referred to in most cases is of the material of the shear zone itself, rather than fluids from other sources. For these reasons the book may not appeal to those interested in hydrocarbon or mineralization aspects of flow along and across fault systems. Nor are there many studies of active deformation zones, although I enjoyed the paper by Collettini & Barchi on apparently active low angle normal faults in the northern Apennines: the issue of whether major normal faults are ever active at low angle dips is still a major problem. Another contribution on active shear zones comes from Maltman & Vannucchi, who review data from several ODP wells that penetrated plate boundaries at subduction zones.

Most of the papers are case studies of particular regions, but there is typically a good emphasis on the processes involved in the deformation, and how to study them, rather than arid applications of standard techniques across unconnected areas of the world. That said, the geographical coverage is broad, ranging from Greenland to Australia, with 10 contributions on the Phanerozoic geology of Europe. The Apennines are represented by four papers, which range from clay deformation processes in a single fault (Casciello *et al.*) to regional tectonic evolution (Molli & Tribuzio).

Several papers cover deformation pathways through different *P–T* conditions, but overall the papers are slanted towards structural studies, not metamorphism. There is also a sub-set of papers that presents advances in the theoretical, analytical or statistical handling of elements within shear zones. Time will tell if any of these become standard references for future work. For example, Giorgis & Tikoff model the behaviour of rotating rigid clasts in shear zones and Gumiaux *et al.* apply statistical techniques developed in the mining industry to cleavage measurements from Brittany.

An undercurrent throughout the book is the strength profile of continental lithosphere, which must determine the style and extent of deformation. Some papers, including the useful introductory review by Alsop & Holdsworth, cite the classic 'butterfly wing' strength profile that has maxima in the mid crust and upper mantle lithosphere. Other papers take note of recent work that suggests that the strength of the lithosphere lies mainly within the brittle crust, and interpret their findings in this light; the review of mantle shear zones by Dijkstra *et al.* is perhaps the best example.

In summary, this is a very useful book for geologists working on shear zone processes in the continents. It will be less useful for those working on oceanic lithosphere, hydrocarbon geology or mineralization processes.

Mark Allen