

BOOK REVIEWS

WINTERWERP, J. C. & VAN KESTEREN, W. G. M. 2004. *Introduction to the Physics of Cohesive Sediment in the Marine Environment*. Developments in Sedimentology Series no. 56. xiii + 466 pp. Amsterdam: Elsevier. Price 120 Euros. £80.00 (hard covers). ISBN 0 444 51553 4. doi:10.1017/S0016756806211944

Most of the seabed is covered in mud. Muddy coasts occupy a very large proportion of the Tropics. Most of the stratigraphic record is made of mud rocks. Geochemical calculations indicate that at least 60% of all sediments are fine-grained. This dominance is, however, largely ignored in treatments of sedimentology and in textbooks on sediment transport mechanics. The reasons are not hard to discern: the materials are not amenable to study with the microscope or, in most cases, with the naked eye; information is extracted via laborious and time-consuming procedures; the mechanical behaviour of the material is made extremely complex by the tendency of the particles to stick together; and mud is very nutritious, supporting a rich biota which influences the properties and behaviour of the particles. Sand by comparison is simple.

The field of cohesive sediment dynamics which deals with principles underlying the mechanical behaviour and the transport and deposition of fine-grained sediments has long been in need of a book such as this. It is, indeed, the first and presently the only textbook devoted to cohesive sediment dynamics. The authors are from the renowned Delft Hydraulics Laboratory which has had a long involvement in problems of cohesive sediments in the field, both in the estuaries and tidal flats of the Netherlands and in tropical settings of the East Indies and South America. The authors have had this long laboratory experience in field programmes and laboratory experiments and theory to draw on.

The book covers all the major fields that one would expect, with chapters covering boundary layer fluid flow, basic sediment properties, processes of flocculation and consequential changes in settling velocity and sedimentation, sediment–fluid interaction (mainly the problem of stratification of the fluid by high concentrations of suspended sediment), consolidation of sediment columns, the mechanical behaviour of cohesive sediments, sediment erosion, biological effects, and gas in sediments. The approach is accessible to most with a reasonable mathematical grounding, but detailed mathematical derivations are not a prominent feature of the treatment. The authors do use tensor notation, but include an appendix on tensors as well as an appendix on their one-dimensional vertically integrated model ('1DV point model'), which is used to calculate a number of the values used as examples in the book. An area of concern to geologists not covered here is the occurrence of bedforms of erosional or depositional origin. Bed roughness forms in mud include various erosional structures, transverse and longitudinal ripples, furrows and, at very large scale, mud waves. They certainly influence the flow near the bed and would have been appropriate to treat here.

Communities often operate in the same field but in considerable ignorance of what the others are doing, a division that can be seen here between engineers concentrating on shallow marine/coastal environments and oceanographers working

on the shelf and deep sea where most mud is found (but is far less amenable to study). This shows up principally in the chapter on biological effects, which is rather brief and does not extend beyond cursory treatment of the coastal zone, and has not included any of the contributions of marine biologists and sedimentologists to biological moderation of sediment dynamics, for example, the work of Allredge, Dade, Eckman, Jackson, Jumars, Nowell and Wheatcroft, whereas Paterson's fine work on tidal flats is well to the fore. Nevertheless, this is an excellent book that demands to be in all geological libraries and owned by teachers and researchers in sediment transport. It should be consulted by those teaching courses on the mechanics of sediment transport and deposition, in order to achieve a balanced treatment that is not based solely on sand transport and turbidity currents.

I. N. McCave

FLÜGEL, E. 2004. *Microfacies of Carbonate Rocks. Analysis, Interpretation and Application*. xx + 976 pp. Berlin, Heidelberg, New York: Springer-Verlag. Price Euros 99.95 (+ VAT at local rate), SFr 169.00, £77.00, US \$99.00 (hard covers). ISBN 3 540 22016 X. doi:10.1017/S0016756806221940

It is hard to imagine a more unfashionable topic and certainly not one that most research councils or committees charged with research assessment exercises would regard as top-level progressive science. Yet the topic, carbonate microfacies, is the cornerstone of carbonate sedimentology, especially for subsurface work. Without the ability to understand the origins of carbonate rocks then the hosts for nearly 50% of the world's oil and gas would be a mystery to us; with the era of high priced energy already begun the ability to understand the distribution of oil and gas is even more critical than in the past. As in the earlier editions this monumental, definitive tome is set to be a bible for the carbonate sedimentologist for at least a generation; I still regularly use my 1982 copy because it contains so much basic information. This version is a much expanded, up-to-date and very clearly laid out reference work with a CD containing a massive reference list, although the end of each section in the book has lists of key references. Colour is used, although sparingly with 30 images, but at only £77 this huge book is a bargain.

There are 19 chapters, in three sections. Chapter 1 introduces some issues in the book and Chapter 2 covers essential terminology of carbonate environments and controls. Chapter 3 begins the first of the main sections, with a practical look at how to do microfacies analysis. Chapter 4 covers microfacies data with matrices and grains; it is full of boxes with practical advice such as a whole page devoted to 'How to describe an oncoid'. Chapter 5 looks at fabrics and their meaning. Chapter 6 is devoted to quantitative analysis, from grain size to multivariate analysis; I was surprised to see some important studies not given as much coverage as less deserving topics but that is a personal quibble. Chapter 7 focuses on diagenesis, porosity and dolomitization, and here many readers might be disappointed at the lack of detail and geochemistry; this can be explained by the fact that the book,

like the earlier versions, is really about palaeoenvironmental analysis rather than diagenesis, but readers will be surprised not to see Jerry Lucia's classification of pore types in this chapter. Chapter 8 looks at classification. Chapter 9 reminds the reader about the fact that limestones are biological sediments with detailed looks at stromatolites, encrustations and bioerosion. Chapter 10 is a book in itself with 175 pages devoted to the recognition of fossils in thin section; this is an invaluable review.

Chapter 11 starts the section on microfacies interpretation by summarizing microfacies criteria and how to define microfacies types, and it is a perennial problem for the petrographer to compress nature's complexity into a format for ease of communication. Chapter 12 covers palaeoenvironmental recognition and provides practical information on identifying storm beds, to oxygen levels, to water depths, etc., and worked examples are provided to help the reader. Chapter 13 integrates non-carbonate features into facies analysis. The next chapter looks at depositional models and standard microfacies types. In Chapter 15 specific facies are reviewed as well as caliche, palaeokarst and non-marine carbonates. Chapter 16 looks at depositional constraints and processes, such as cyclicity, sequence stratigraphy, reefs, and even vent communities, as well as carbonates through time; the debate about cyclicity and order in carbonate rocks was not captured in this short chapter. Chapters 17–19 look at the practical uses of microfacies data, covering reservoir rocks, building stones and archaeological uses; the reservoir chapter is very brief indeed considering the importance of the topic. The appendix contains answers to the exercises set earlier in the book.

This book does what the title states. It is about microfacies in limestones. It is not a book with full coverage of modern and ancient carbonate deposystems, neither does it fully cover diagenesis nor applied sedimentology; it is about microfacies and it is an exhaustive treatment and that is its strength. I fear that the ability to describe and provide a measured interpretation of a limestone in thin section is a dying art but at least this *magnum opus* is a record of the subject for posterity. As many readers will appreciate, plumbing was once an unfashionable trade but now the plumbers are more valuable than interior decorators.

Who should have a copy? There should be copies in every university library and petrology teaching laboratory, oil company and service company and it should have a place on the shelves of every sedimentologist. It is a book the young sedimentologist will have to read methodically, and the experienced specialist can still learn much from it. Like all bibles it is also a book that can be consulted when in trouble and I know I will be using my copy every time I find some unknown grain.

Eric Flugel died shortly after completing this book but he leaves a legacy for many decades to come.

Paul Wright

LIVIO, M., REID, N. & SPARKS, W. (eds) 2005. *Astrophysics of Life*. Space Telescope Science Institute Symposium Series no. 16. xi +110 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £55.00, US \$100.00 (hard covers). ISBN 0 521 82490 7.
doi:10.1017/S0016756806231947

This slim, but rather expensive, volume emanates from the organization in charge of the famous Hubble Space Telescope, and this locale justifies the editors' remarks that 'Unlike

other astrobiology symposia, the emphasis here was on astronomical observations and astrophysical research' (p. xi). As such it forms a very welcome counterpart to the many other astrobiology volumes where other important topics such as origin of life, extremophiles, planetary atmospheres and the search for extraterrestrial signals are all well reviewed. To many these topics in astrobiology seem remote, but there are at least four reasons for any reader of *Geological Magazine* taking notice. First, even what we know of our Earth in comparison with Mars, Venus, Europa and most recently Titan suggest intriguing differences and similarities. Second, the edge of technology is advancing at a prodigious pace, and whilst the main surveys for remote Earth-like planets (such as *Kepler* and *Terrestrial Planet Finder*) are still some years away, existing refinements of technique and technology suggest that what even a few years ago would have seemed like science fiction may now be on the verge of reality. Third, just as no man is an island, so Earth is embedded in a galactic environment that may impinge, sometimes less than subtly, on our home planet. Finally, astrobiology is a superb teaching tool, an interdisciplinary enterprise that readily captures the imagination of students.

Many of these aspects come to light in the nine chapters of this book. Two, those by Pascale Ehrenfreund *et al.* and Scott Sandford, deal with the all-important question of organic compounds in interstellar space. Why so important? Simply because it looks increasingly likely that a significant part of the organic inventory necessary for life to originate on Earth (or Mars) was delivered by comets during the early accretion of the planets. This is a tantalizing prospect for at least two reasons. First, did this inventory pre-determine at least some primitive biochemistry? If it did, then alien biochemistries might be much more similar to Earth than is often suggested. Second, is it even possible that some pre-biotic processes necessary for a fully functional cell actually occurred in environments and locations very distant from the Earth? Yet there is still much to learn. More than 120 molecules have been identified by infra-red spectroscopy, and interesting reaction schemes such as might occur on interstellar grains can be devised, but the possible links to the origin of life are still elusive. Interstellar detection of amino acids, the necessary building block of proteins, is still problematic, but the rich array of amino acids found in some meteorites does point to extraterrestrial, if not interstellar, processes. The snag here is what the meteorites show in relative abundance does not accord well with expected synthesis pathways.

Other chapters address the topic of planets. Kailash Sahu, for example, deftly explains the strange effect of relativity that leads to the detection of extra-solar planets by gravitational microlensing. The disadvantage is that each lensing event is unique and fortuitous, and to date positive results are very few. The advantages, however, are potentially enormous. The telescopes needed are modest in size, the number of events in principle is still large and most importantly even small planets can be detected. It is, therefore, an area of enormous promise. So too are other methods. Radical velocity methods, involving Doppler shifts of the starlight caused by the gravitation of the orbiting planet, are at present pre-eminent but suffer the disadvantage of being unable to detect planets smaller than about Neptune. Like gravitational microlensing, searching for planetary transits is another very promising area. Ronald Gilliland ably reviews the evidence, and is upbeat about the limits of detection. Identification of planetary rings and moons are already on the cards, while both the potential for detecting atmospheres and extending the search area to Earth-sized

planets (maybe!) shows this is an area of great promise. As and when a planetary atmosphere is recognized then we may well be on the threshold of knowing whether there is life beyond our Solar System. Thus Sara Seager and E. B. Ford explain how an Earth-like atmosphere may be recognized, notably by the famous 'red edge' spectral signature that on Earth is associated with plant reflectivity. Here too we are beyond the present limits of detection, but that will soon change.

The recognition that the Earth's history is by no means immune to extra-terrestrial influences, not least by bolide impact, is now part of everyday thinking. Yet the wider cosmic context is much less appreciated. The chapter by Priscilla Frisch and colleagues is a salutary reminder that our isolation, and insulation, is relative. Here they fascinatingly review the relationship between the solar wind and the outer interstellar medium. Given the heliopause is currently located at about 140 AU, this may seem all very remote. Not really; first circumstances change and the so-called Local Bubble in which we are presently embedded is a relatively recent phenomenon, dating back only about 2 Ma. It confers considerable protection and stability, and it is intriguing that around 2 Ma ago hominid evolution took a leap forward. Could there be a connection? Earlier the Solar System may have found itself in a different and maybe less benign environment that could have had major consequences, including climatic. Similarly extra-solar planets may be embedded in very different heliospheres, possibly having profound effects on any life.

The final two chapters are also very thought-provoking. Guillermo Gonzalez reviews his by now familiar ideas concerning the nature of the Galactic Habitable Zone (GHZ). Here he emphasizes the importance of a star's metallicity (and yes, to an astronomer, any element heavier than He is a metal) in terms of planet production. This, and proximity to such disturbing influences as globular clusters, black holes in galactic centres, and the nature of galactic orbits, all suggest the GHZ is quite restricted and as Gonzalez has argued elsewhere the locality of the Earth might be extraordinarily favourable. Finally, the senior editor, Mario Livio, offers a wide-ranging and thought-provoking overview of the links between life and cosmology.

This is an area moving fast, and no department of geology should be losing the opportunity of teaching this area. Metal-rich stars, carbonaceous meteorites, gravitational microlensing and the fine structure constant may seem arcane additions to a world more familiar with basalt and brachiopods, but rest assured our scientific future is very largely 'out there'.

Simon Conway Morris

Catastrophes and Lesser Calamities is a timely effort to try and mop up some of the mess some 25 years after the event. The author, Tony Hallam, needs no introduction to geologists having been an active academic palaeontologist and stratigrapher over several decades now. Those who know his work will not be surprised by his approach to mass extinctions.

As Hallam says in his preface, he has been frustrated by the 'unbalanced and over-sensationalized treatment of the subject of mass extinctions by the media'. Just as bad has been the 'tendency among some very able scientists, both within and outside the Earth-science community, to ascribe many or even all catastrophic mass-extinction events to the impacts of asteroids or comets'. As he goes on to say, the result has been that 'events produced by changes solely confined to our own planet have been underplayed'. In this book aimed at a popular readership his intention is 'to redress the balance and put impacts within the context of a number of purely Earth-bound events . . .'

The downside of all the K/T event publicity is that many scientists who have no knowledge of geology do find it difficult to understand what all the fuss is about and why geologists cannot come up with straight-forward answers to the cause of extinction events. Hopefully, they will read this book, learn something about the more significant P/T event and begin to get some idea of the nature of the rock and fossil record and problems of sampling and temporal resolution of critical data. Geologists often fall into the trap of being so familiar with the problems that we can at times find it difficult to see that others do not understand the niceties.

In *Catastrophes and Lesser Calamities* Hallam gives a well balanced overview of the big five extinction events, all their complex interacting processes and events and their possible causes both earth-bound and extra-terrestrial. Changes in climate, sea level, ocean chemistry and volcanic activity are all reviewed along with bolides. Altogether *Catastrophes and Lesser Calamities* provides an excellent account for students and the general reader.

An appendix provides ample 'notes and suggestions for further reading' which are then followed up by an excellent bibliography, glossary and index. And, there is a useful selection of black-and-white photos, tables and maps.

With all our recent reminders of the power of natural processes to disrupt and destroy life, I hope that at last more attention might be paid to internal earth-bound causes of extinction.

Douglas Palmer

HALLAM, T. 2004. *Catastrophes and Lesser Calamities. The Causes of Mass Extinctions*. xii + 274 pp. Oxford: Oxford University Press. Price £12.99 (hard covers). ISBN 0 19 852497 8. doi:10.1017/S0016756806241943

Neocatastrophism has been with us for a few years now. I suspect that renewed interest in this approach to earth science probably predates the 1980 Alvarez *et al.* paper that linked the K/T extinction with an extra-terrestrial cause. Stratigraphers such as Derek Ager were certainly pedalling neocatastrophism back in the 1970s but there is no doubt that the impact of the Alvarez bolide sent shock waves through the geological community and we are still experiencing the swash and back-wash.

RAMÓN-LLUCH, R., MARTÍNEZ-TORRES, L. M. & APRÁIZ, A. 2005. *Introduction to Geological Mapping*. 214 pp. Bilbao: Universidad del País Vasco. Price Euros 21.25 (paperback). ISBN 84 8373 638 1. doi:10.1017/S001675680625194X

In spite of its name, this book is not about geological map-making at all, but is instead a textbook on the interpretation of geological maps. The authors, who have taught undergraduates this subject for many years, have set out to link basic theoretical concepts with practical exercises employing geological maps. The theoretical background is rather brief and occupies only the first quarter of the book, the rest being made up of map-based exercises and their solutions.

The theoretical part of the book is divided into six brief sections:

- (i) Spatial orientation of geological elements –conventions for recording the attitudes of linear and planar structures in numerical and graphical formats;
- (ii) Projection systems in orthographic projections – the construction of a plane from three points of known elevation;
- (iii) Projection of topographic surfaces – the use of topographic contour lines;
- (iv) Intersection of a plane surface with topography – outcrop patterns and the V rule;
- (v) The map interpretation method – the practical stages involved in interpreting the geological structure from a map;
- (vi) Description of some cartographic elements – determination of dips of beds, the stratigraphic sequence and the geometry of faults and folds.

These concepts are well illustrated with figures, but unfortunately the text suffers from imperfect English which in some places could lead to confusion. A useful part of this section is the thirteen pages of cut-outs that can be folded and glued to build three-dimensional models. These models illustrate structures such as faults, plunging folds, and igneous intrusive bodies.

The value of this book lies in the map exercises that form the second part of the book. These vary greatly in complexity from simple structures consisting of horizontal rock units through to maps with refolded fold structures. Solving many of these map exercises will require tutorial help because the underlying principles are not covered in the foregoing text. The maps are invented ones, but the majority are detailed enough to resemble the real thing. The task in each case is always to construct a geological section from the map information.

Other exercises consist of given cross-sections from which a geological history is constructed. The solutions to these and the map exercises are given.

The poor technical writing and use of non-standard terminology, together with the scant theoretical explanations, will mean that the book will have limited appeal to students. On the other hand the book will be of value to course instructors. They will appreciate the cut-out models, the interesting range of exercises and the published solutions.

Richard Lisle

WALL, F. & ZAITSEV, A. N. (eds) 2004. *Phoscorites and Carbonatites from Mantle to Mine: the Key Example of the Kola Alkaline Province*. The Mineralogical Society Series no. 10. xv + 498 pp. London: The Mineralogical Society of Great Britain and Ireland. Price £89.00 (hard covers); introductory price £49.00. ISBN 0 903056 22 4.
doi:10.1017/S0016756806261946

Phoscorites are rare plutonic igneous rocks that until recently have been largely unheard of outside the Russian literature. They essentially contain magnetite, apatite, forsterite/diopside or phlogopite and an array of unusual accessory mineral phases (e.g. baddelyite, zirconolite, calzirtite). Phoscorites are commonly associated with carbonatite complexes. Their main occurrences are in the Kola and the Maymeicha-Kotui alkaline provinces but their recent

recognition in the international literature will almost certainly result in new identifications from global carbonatite complexes. *Phoscorites and Carbonatites from Mantle to Mine, the Key Example of the Kola Alkaline Province*, edited by Frances Wall (Natural History Museum, UK) and Alexandra Zaitsev (St Petersburg State University, Russia), is the tenth volume in the Mineralogical Society Series of publications. The book is an up-to-date coherent compilation of carbonatite complexes in the Kola alkaline province. It consists of 14 thoroughly reviewed and edited chapters, predominantly written by Russian scientists.

In Chapter 1, Bulakh *et al.* provide an historical overview of the discovery and prospecting of carbonatites complexes in the Kola alkaline province. Some of this relates to the political significance of the mineral deposits, especially between 1930 and 1990. This is followed by an introduction to the occurrence, composition, nomenclature and petrogenesis of carbonatite–phoscorite complexes by Krasnova *et al.* and a discussion of the geochronology of the Archaean to Palaeozoic alkaline magmatism on the Kola Peninsula by Kramm & Sindern. They conclude that most plutonic and hypabyssal intrusions were emplaced during the Devonian but there is no systematic distribution of ages or correlation with tectonic structures.

There is still controversy relating to the origin of phoscorites; are they the results of crystal fractionation from a carbonated silicate melt or liquid immiscibility of carbonatite and silicate melts? This debate may not be resolved until detailed experimental and trace-element partitioning studies are undertaken. In Chapters 4, 5 and 6 the field relations and mineralogy of individual phoscorite–carbonatite complexes at Kovdor, Sokli and Vuoriyarvi are discussed. Due to extensive mining, the Kovdor complex is one of the best exposed in the Kola alkaline complex. Despite this, Krasnova *et al.* suggest that the origin of the phoscorites is uncertain. In contrast, Lee *et al.* propose that phoscorites in the Sokli complex are the result of liquid immiscibility between Fe–Ti and carbonate-rich melts whereas Karchevsky & Moutte prefer a crystal fractionation origin for the Vuoriyarvi phoscorites. This debate is highly comparable to that relating to carbonatite genesis, which is the focus of Chapters 7 and 8. The Sallanlatvi carbonatite complex lacks primary parental magmas but contains rare magnesite and siderite carbonatites. Zaitsev *et al.* describe the mineral and bulk-rock chemistry of these rocks and speculate on their origin by crystal fractionation of a hydrous carbonatite magma. The Afrikanda complex contains olivine- and clinopyroxene-rich cumulates with subordinate melteigites and ijolites cross cut by carbonatite veins that are associated with 50(!) mineral species. Chakhmouradian & Zaitsev propose that the parental magmas of the Afrikanda complex were derived by partial melting of pargasite- and phlogopite-bearing metasomatized lithospheric mantle.

Chakhmouradian & Williams examine the behaviour of high-field-strength elements (HFSE) during the cooling and crystallization of carbonatite magmas. These elements are highly soluble in H₂O-bearing carbonatites and are primarily hosted by baddelyite, zirconolite, perovskite-, pyrochlore and ilmenite-group minerals. As well as primary igneous minerals, deuteritic and secondary hosts of HFSE-bearing phases (e.g. vigezzite) are also discussed. The chapter ends with an interesting discussion of the role of HFSE in the evolution of phoscorite and carbonatite magmas.

The diversity and occurrence of rare-earth minerals in Kola carbonatites is discussed by Wall & Zaitsev. They comment on the importance of the rare-earth minerals (such as ancylite,

burbankite and monazite) in recording the final magmatic stages occurring in carbonatites and also the associated fluids. Interestingly, these minerals are rare in phoscorites in which the rare-earth elements are hosted by apatite. Rudashevsky *et al.* review and compare PGE, noble metal and sulphide mineralization in phoscorites and carbonatites from the Kovdor and Phalaborwa complexes.

The use of stable isotopes (C and O) to constrain the relationships of phoscorites and carbonatites and their melt source regions is discussed by Demény *et al.* They present new data and reveal that phoscorites and carbonatites from the Sokli complex have similar stable isotope values, supporting an origin by liquid immiscibility. In contrast, phoscorites and carbonatites from the Turiy Mys Massif have different $\delta^{13}\text{C}$ values (in addition to variable radiogenic isotopic ratios) suggesting that they were derived from different melt source regions.

Bell & Rukhlov provide a detailed discussion of the role of crystal fractionation (Kandaguba) and liquid immiscibility (Turiy Mys) and discuss the radiogenic isotope systematics of carbonatites from the Kola alkaline province. They propose that the alkaline magmas are derived by partial melting within an upwelling plume head, which contrasts with the lithospheric mantle source suggested by Chakhmouradian & Kaitsev in Chapter 8. In the final chapter, Petrov describes the economic deposits and environmental factors associated with mining in the Kola alkaline province.

In summary, the book contains a wealth of information on the petrology, mineral and bulk-rock chemistry of both carbonatites and phoscorites and highlights the controversies relating to their formation. It is well edited and illustrated with numerous colour maps and back-scattered electron images together with a useful eight-page index. The volume will be of especial interest to alkaline igneous rock and rare-earth mineral enthusiasts.

Sally Gibson

AX, P. 2000. *Multicellular Animals, Volume II. The Phylogenetic System of the Metazoa*. xxiv + 396 pp. Berlin, Heidelberg, New York: Springer-Verlag. Price Euros 229.00 (+ VAT at local rate), SFr 387.50, £176.00, US \$241.00 (hard covers). ISBN 3 540 67496 3.

AX, P. 2003. *Multicellular Animals, Volume III. Order in Nature – System Made by Man*. xii + 317 pp. Berlin, Heidelberg, New York: Springer-Verlag. Price Euros 179.95 (+ VAT at local rate), SFr 304.50, £138.50, US \$199.00 (hard covers). ISBN 3 540 00146 8. doi:10.1017/S0016756806271942

The study of animal evolution, fuelled by dramatic contributions from molecular biology and striking discoveries in the fossil record, is an area of exceptional scientific vigour. Peter Ax, one of the senior figures in animal phylogeny, here completes his trilogy, some seven years after the appearance of the first volume (which was reviewed by me in *Geological Magazine* **134**, 276 (1997)). And to the first approximation not very much has changed. Ax is a committed cladist and his text bristles with assertions that such and such a way *is* correct, because of the near-infallible uncertainties of the methodology and the careful (even laborious) assembly of autapomorphies. Evolutionary convergence is recognized, but for the most part there is a relentless drive for rigour and a crystallinity of approach. Alternatives are usually given short, and sometimes dismissive, shrift, and in one memorable phrase he contemplates the high-priest and

founder of cladistics, Will Hennig (actually others preceded him), as turning in his grave (p. 155, vol. III) were he to hear of some heretical suggestions.

In some ways this is all good, clean fun: robust opinions are important and nobody can complain of Ax not putting his cards on the table. So too as a compilation of animal diversity and structure this is a valuable catalogue. Autapomorphies and plesiomorphies are carefully listed, and just as a data source these two volumes are of great value. Yet despite this there are some real drawbacks. Perhaps most importantly the wealth of molecular data is largely ignored. Now, maybe some of the proponents are over-enthusiastic and there is still much to learn, but to see annelids and arthropods joined as the Articulata or to find brachiopods nestling within kissing distance of the deuterostomes rather than embedded in the lophotrochozoans, is certainly surprising. In addition, for the most part the fossil record receives little attention. Exceptions there are, notably with the echinoderms and some vertebrates, but these are rather brief and the great wealth of palaeontological data is largely overlooked. Finally, whilst the atomistic cladist will delight in Ax's surveys, the text tends to be rather lifeless and automatic. These are the characters, so Ax seems to say, and this is the conclusion. All else is irrelevant, even fantastical. Functional realities, concerted convergence, reversal and simplification all are rather distant thoughts, to be sure touched on here and there, but mostly dismissed as the immense edifice of phylogenetic relationships, built on the irrefutable logic of cladistic certainty, is erected before our eyes.

What Peter Ax has achieved is in many ways very impressive. If these two books were not so expensive, it would be an automatic recommendation that the entire trilogy should be on the bookshelf of any serious biologist. It contains a wealth of information, and however much one might disagree with the conclusions, nobody can doubt that from his given perspective Ax has produced serious hypotheses that certainly deserve discussion. Perhaps the subject is now simply too large for one man to encompass all its aspects. Ax has given us one view, firmly cladistic and in its own way a worthy contribution to the many brilliant German contributions to zoology, but it is only one view and not, I suspect, the one that in many areas will find general agreement, even today.

Simon Conway Morris

TAYLOR, P. D. (ed.) 2004. *Extinctions in the History of Life*. xii + 191 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £40.00, US \$70.00 (hard covers). ISBN 0 521 84224 7. doi:10.1017/S0016756806281949

Species come and species go and as palaeontologists are well aware by far the majority of species that have ever lived are extinct. How, why and when this has happened in the geological past is a matter of great interest. In *Extinctions in the History of Life* six international experts on different aspects of the fossil record review questions of extinction from their own perspectives.

These range from Schopf's overview of 'Extinctions in life's earliest history' through Bottjer's 'The beginning of the Mesozoic' following the Permo-Triassic extinction to Wignall on the 'Causes of mass extinctions' and finally Jablonski on 'The evolutionary role of mass extinctions'. The editor, Paul Taylor, starts off the collection with a very useful overview and history of the development of our recognition

and understanding of extinction as a palaeontological phenomenon.

Although many palaeontologists familiar with the field will find that several of the essays reprise arguments presented elsewhere, there is still something for everyone. And students will find it a particularly useful selection and introduction.

Personally, it is plant extinction that I know least about – did they or did they not suffer mass extinctions in the same way that animals have? There is an indication that plant species did not suffer much more than a 10% decline in diversity from any of the major extinction events and hardly any drop at the highest taxonomic level.

Scott Wing provides a well-argued essay that attempts to answer the question and explain the complexities of the issue to non-plant people. As he writes, ‘overall, the response of plants to mass extinctions is different from that of animals but not as different as we might have thought . . .’ Critically, it is the evolution of extinction-resistant weedy forms in many of the major plant groups that has allowed them to survive. As a result our perceived macroevolutionary patterns derived from the fossil record of major plant groups is deceptive and does not look like the patterns produced by the fossil record of major animal groups.

Wing compares the action of mass extinction on animal and plant groups as equivalent to a chainsaw massacre (he does not use the word massacre) and a shotgun blast. Animals are cut off in big branches whilst plants are selectively culled all over the place and the former mode is much easier to detect within the rough and ready measures derived from the fossil record.

Each essay has its own set of references and overall the diagrams, tables and even the black-and-white photos are well produced. There is a useful glossary and index, making *Extinctions in the History of Life* an excellent choice for departmental libraries and those who want a good general introduction to these particular topics.

Douglas Palmer

JOHNSON, D. 2005. *Geology of Australia*. First paperback edition; first published 2004. xii + 276 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £27.99, US \$45.00 (paperback). ISBN 0 521 60100 2 (paperback). doi:10.1017/S0016756806291945

The Geology of Australia by David Johnson provides an ideal introduction to the subject for students. The wide-ranging

text starts with what he calls ‘A Geology Primer’ – the basic structure of the Earth, plate tectonics, dating techniques, etc., some 30 pages in all. This is all useful stuff but perhaps the pages could have been more usefully taken up with greater detail on economic geology but clearly this is intended as a ‘one stop’ introduction to Australian geology.

Then there is a progression through the geological history of the continent from the early Precambrian assembly to Rodinia and brief information about the origin of life and the fossil evidence. The subsequent four chapters are based on major climate changes related to plate movement so that we have lower Palaeozoic ‘Warm Times’ from the Cambrian through to the Devonian followed by the ‘Icehouse’ of the Carboniferous and Permian glaciation, then ‘Mesozoic warming’ and ‘Birth of Modern Australia: flowering plants, mammals and deserts’. The whole historic section takes around 100 pages. Along the way many topics are covered in both general and specific ways e.g. fossil preservation, volcanic arcs, climate change. Overall this is a useful and interesting way of dealing with geological history which all too often can become something of a monotonous progression and clutter of stratigraphic names but not here.

The remaining 100 pages of the book are divided into a further five chapters that deal with a range of topics specific to the Australian context such as volcanoes especially in the Eastern Highlands and offshore seamounts, ‘Building the continental shelf and coastlines’, the Great Barrier Reef, planetary geology and impact craters and finally cycles of climate change, plate movement and deformation, and evolution and extinction. According to Johnson ‘it has not been possible to include the details of the origin of our many world-class ores, coal and petroleum deposits, and the economic geology which underpins so much of our quality of life’.

Each chapter is well organised for the student reader with an initial brief synopsis, clearly labelled sections, boxes on special topics such as fossil preservation, climate change, P/T extinction, and then the chapter ends with a summary. The text is well illustrated with colour photos, maps, drawings and tables. Each chapter ends with a selection of up-to-date sources and references, including websites and finally there is an index.

This is as good a starting point as you will get on the geology of this fascinating continent and its wider context within the development of Gondwana, and it is an attractively presented text which should appeal to students and be easy to use.

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