REVIEWS

MOORES, E. M. & TWISS, R. J. 1995. *Tectonics*. ix + 415 pp. New York: W. H. Freeman. Price £29.95, US $59.95 (hard covers). ISBN 0 7167 2437 5.

This book is a companion to *Structural Geology* (1992), also published by Freeman, and by the same authors but with the order of their names reversed. There is of necessity a slight overlap in content between the books but it enables each one to stand alone. In their Preface, Moores & Twiss explain that the scope of tectonics from their perspective deals with '… features at scales ranging from the regional to the global', emphasizing that there is a continuum of scales between phenomena usually thought of as being the preserve of structural geologists and those of concern to tectonicians. They strongly recommend that these two groups of scientists should be aware of each other's thinking; those working outside these disciplines will be surprised that such a recommendation is needed but there is less exchange of ideas between the two groups than might be imagined.

Tectonics is an undergraduate text-book in the traditional sense of that class of book; it does not, for example, take a strongly personal perspective about what topics are more important than others, neither do the authors overtly push some interpretations at the expense of others. This balanced approach does not, however, mean that the book is dull, the authors' approach being especially thoughtful. *Tectonics* is divided into three parts: I, Introduction; II, Plate Tectonics; and III, Tectonic History, parts II and III being separated by a twelve-page 'Interlude' on 'The Scientific Method and the Plate Tectonic Revolution'. This Interlude is an excellent account of ideas set in their philosophical and historical contexts. Moores & Twiss define what they understand by the terms fact, model, hypothesis, theory and law; roughly equating the meanings of hypothesis and model. They also emphasize that a useful model should be testable, powerful and parsimonious. Although use of the word parsimonious is vivid perhaps they did not really mean that the a tectonic model should be *unduly* economic; merely, as they explain, satisfy the principle of Occam's razor.

Chapter 1, in the introductory part of the book, is an overview of the attributes of tectonics and structural geology set in a global context, while Chapter 2 focuses on 'Geophysical Techniques in Tectonics'. It is in this chapter that we encounter the first of many boxed items of information. Within these boxes, which can be read separately, text and diagrams are used to explain technical material, commonly methodological, which needs to be understood, but which if included in the main text would interrupt the narrative flow.

The core of *Tectonics* is Part II in which all the principal plate-tectonic environments are discussed after initial chapters dealing with the 'Principal Tectonic Features of the Earth' and 'Plate Tectonics'. Of the many accounts in text-books of plate tectonics this one is especially clear and accessible. The chapters that follow are 'Divergent Margins and Rifting', 'Transform Faults, Strike-Slip Faults and Related Fracture Zones', 'Convergent Margins', 'Tectonics and Geology of Selected Triple Junctions', and 'Collisions'. Of these chapters the headings of most are predictable, but necessary, and the treatment of the topics is likewise more or less conventional, although not everyone would agree that listric normal faults dominate the Basin and Range province of the American west. The inclusion of a chapter focusing on the tectonics and *geology* of triple junctions did, when I read the contents list, raise my expectations that some very special parts of the continents might be discussed in addition to those of the oceans. However, with the marginal exception of the Fuji triple junction, within the Japanese mainland, this opportunity was not taken. For example, the Karliova and other truly intracontinental triple junctions in Turkey and neighbouring States to the east have been the subject of numerous articles, and their complex tectonics deserves inclusion in some future text-book.

In my opinion Part III, 'Tectonic History', is the best part of this book, perhaps because some of the material is less familiar to me than that in other parts; the reaction of a student might, however, be quite different. After a short introduction the authors give an account of the 'Anatomy of Orogenic Belts' in Chapter 10. The material in this chapter is a comprehensive round-up of the principal attributes of orogens and their structures; the emphasis is mainly on Mesozoic–Cenozoic belts but includes a review of the Appalachian–Caledonide mountain belt.

Chapter 11 is devoted to 'Neotectonics'. I was pleased to see that the authors are willing to use this term to describe a discipline that integrates a range of earth science methodologies from seismology, through geodesy and geomorphology to geology in order to understand not only recent processes but also ancient tectonics and, most importantly of all, the assessment of future earthquake hazards. The authors go on to present several 'Case Studies of Orogenic Belts' in Chapter 12; the initial examples chosen are young mountain belts, from the Western Cordillera of North America, predictably being treated first, to the Alpine–Himalayan belt. There then follows a look at the Applachian–Caledonide system with examples of terrane amalgamation highlighted. A topic less commonly addressed in tectonics text-books is the 'Tectonics of Terrestrial Planets', the theme of Chapter 13. A substantial Appendix gives information about 'Map Projections', a useful reminder that perceptions can be shaped by an arbitary choice of reference frame.

What is missing? Perhaps the most obvious gap for European students is a serious discussion of the Variscan (Hercynian) orogen within which they are likely to spend days or weeks of field work. Its status in this book is reduced to that of being a closing stage of Appalachian–Caledonian orogenesis – fine for North America but not Europe. Perhaps more importantly there is no focus on basin tectonics. Mountain belts, the traditional training grounds of structural geologists, are given pride of place. Likewise, inversion tectonics, especially of the type encountered in many basis containing petroleum, is not mentioned; it is perhaps too new a topic to be given prominence in this book but some reference to it was surely needed.

Moores & Twiss provide the reader with some well chosen additional reading, only four or five cited papers being in a language other than English. From a practical point of view this was perhaps a sensible decision considering the book's likely readership, but it is bound to reinforce the notion that only science which is published in English is worthwhile science.

As one would expect from W. H. Freeman, the editing and appearance of *Tectonics* is excellent. Figures are either new or have been redrawn from their original sources, the simplicity of their design being an object lesson not only to other text-book writers but also to everyone who aims to transmit their ideas in graphical form. It is quite difficult to spot typos – 'sheer' stress

on page 230 appealed to me, having read it so many times on examination scripts.

Despite, as most reviewers do, having found a few things to quibble about, I conclude that this book can, with only a few reservations, be recommended to students. *Tectonics* is clearly written, well structured, beautifully illustrated, and reasonably balanced in its approach.

P. L. Hancock

ARCHIBALD, J. D. 1996. *Dinosaur Extinction and the End of an Era. What the Fossils Say.* Critical Moments in Paleobiology and Earth History Series. xviii + 237 pp. New York: Columbia University Press. Price US $49.50 (hard covers), US $25.00 (paperback). ISBN 0 231 07624 X; 0 231 07625 8 (pb).

'Dinosaur' and 'extinction' in the title of the book, the publishers must be on to a winner! Cynical though that might appear it is, I suppose, not too far from the truth; there are probably few other topics, apart from 'Life on Mars', that can grab headlines so effectively nowadays. Given the undoubted popularity of the subject matter, which has been capitalized upon most notably by Luis and Walter Alvarez since 1980 with the rise of the 'meteorite impact' theory, it has been frustrating to see, all too often, that the subject is not treated in a balanced or objective manner, but is invariably prone to exaggeration or inaccuracy – and I am not confining my remarks solely to the popular end of the spectrum. So approaching a book such as this is a sort of toe-curling experience – particularly because it is at the accessible end of the academic publishing market, coming out in a series subtitled 'Critical Moments in Paleobiology and Earth History'.

Dave Archibald has for a long time time upheld the increasingly unfashionable gradualist model for the end-Cretaceous extinction event, concentrating most of his efforts on the small mammal faunas that can be collected from deposits which span the period of time within which the extinction event occurs in the western United States. This account, though broadly-based in terms of the range of subject matter covered, is focused through his work to document in detail the transition in the faunas that takes place across the extinction boundary (between the Cretaceous and Tertiary Periods [the K–T interval] about 65 million years ago). Curiously for such a famous event, there are actually very few places where it is possible to follow a more or less unbroken series of terrestrial sediments across the boundary between the Cretaceous and Tertiary; apart from North America the boundary is most often marked by a depositional hiatus – which actually makes for a very convenient Period boundary.

To set the scene the reader is guided through aspects of geological time, and the nature of extinction events, both the background variety which is understandable within a purely Darwinian natural selection for individual taxa, and the higher orders of extinction which constitute the larger problem which the book addresses: the mass-extinction event, when large numbers of seemingly unrelated groups of taxa appear to go extinct simultaneously. Archibald also very nicely and succinctly contrasts the biological and geological views of extinction before going on to look in some detail at the various vertebrate groups, their basic attributes, and survivorship details across the K/T boundary. This is the central plank of Archibald's approach. Looking at survivorship among the varied and various groups of vertebrates he then tries to assess the degree to which their survival or extinction can be correlated with the current models for extinction – firstly, the most strongly promoted meteorite/comet impact and volcanism are shown to be not as well correlated as might have been expected. He then goes on to look at what might be classified as a range of sea-level related changes and their potential to cause consequential mass extinction, only to conclude that there is again no tight correlation either directly with such changes, or the environmental consequences of such change. Differential survival seems to rule, and a single ultimate cause begins to diminish.

Having concentrated on the animals he knows best Archibald then addresses the botany and marine biology of the K/T and what again appears to emerge is a mixed signal of stepwise and abrupt extinctions on a world-wide basis.

As a synthesis of these disparate lines of evidence Archibald proposes, quite persuasively, for a marine regression and habitat fragmentation as driving forces behind the floral and faunal turnover seen toward the close of the Cretaceous combined with the more specific effects of a meteorite impact and/or large-scale volcanism in the Late Maastrichtian – the latter being in effect 'the straw that broke the camel's back'.

This is a very readable account of the K/T extinction event, is well referenced, and as balanced as one could expect from someone who is an avowed gradualist. I think that it makes a strong case to be recommended reading by undergraduates who are otherwise fed a pretty unadulterated diet of catastrophist theories. It is also reasonably affordable – a rare thing nowadays!

David B. Norman

MCCALPIN, J. P. (ed.) 1996. *Paleoseismology*. xx + 588 pp. San Diego, New York, Boston, London, Sydney, Tokyo, Toronto: Academic Press. Price £69.95, US $89.00 (hard covers). ISBN 0 12 481825 0.

Palaeoseismology is the study of prehistoric earthquakes: more specifically, the attempt to characterize the location and size of ancient earthquakes and, if possible, the amount and sense of slip on the faults responsible for them. This enterprise has been driven by two demands. By far the most important has been the need to find out more about the earthquake record in places where the documented history is rather short, like in California and New Zealand: a demand closely related to seismic hazard assessment. The other demand comes from the study of active continental tectonics. We now have a fairly good general knowledge of the way the continents are deforming, principally through geodesy and seismology, but the details of how the active faults achieve the overall motions are still obscure in many places, because we don't know how fast they are moving. By establishing the earthquake history on faults, palaeoseismology can contribute substantially to this subject.

As an activity, palaeoseismology has mushroomed over the last two decades, and changed from being a tool of use in other disciplines to an unquestioned aim in itself. This is reflected accurately (and perhaps unconsciously) in the preface to this book, where the editor mentions the 'value of collaboration with specialists in structural geology, geodesy, and seismology for solving palaeoseismological problems': twenty years ago it was the other way round. To many people, palaeoseismology means 'digging trenches across active faults'. This is indeed a very large part of the current effort worldwide, and has been tremendously fruitful. But the editor has, sensibly, taken a much broader view of the subject, and the book embraces geomorphology as well as the interpretation of possible indirect indicators of seismic activity, such as liquefaction effects and landslides, all of which can be very important if, for example, the fault does not break the surface.

The book is organized into nine chapters written by ten experienced and authoritative contributors. As well as covering

the obvious sub-division into strike-slip, extensional and compressional environments, there are chapters on landslides, liquefaction, applications to hazard and neotectonic studies, and volcanic environment, as well as an excellent contribution by the editor himself on general field techniques. Each chapter is based around specific case studies, is well illustrated and clearly set out. This is a fine book, and there is no other available that covers this subject. The editor has done well to keep its scope broad, and, in a wider perspective, this book is an excellent companion to another recent volume *The Geology of Earthquakes* by Yeates, Sieh & Allen (Oxford, 1997). The two together show just how rich has been the gain to understanding fault behaviour once we started looking at active ones. Alas, the high price of this book will severely lessen its impact.

Two final thoughts strike me. One is that this book, like all palaeoseismology practitioners, concentrates on what you can see, not what you miss. I await eagerly the day someone does a thorough palaeoseismological control study on a fault with a well-documented and long historical record, like the North Anatolian Fault. The other is that, in spite of the clear and logical descriptions of the trenches in this book and in papers, I know (as a non-trencher myself) that a huge amount of what you can see in them depends on experience. Many times I have stared blindly into trenches, seeing nothing until it is patiently pointed out to me by those to whom it is obvious because they have seen it before. This book is no substitute for that experience, but it is a start.

James Jackson

JENSEN, S. 1997. *Trace fossils from the Lower Cambrian Mickwitzia sandstone, south-central Sweden*. Fossils & Strata no. 42. 96 pp. Oslo: Scandinavian University Press. Price US $32.00 (paperback). ISBN 82 00 37665 6.

To have the opportunity to work on one of the world's most important fossiliferous sites for a Ph.D., is an almost unimaginable situation for most graduates who nowadays are presented with a list of often mundane projects that have survived committee meddling. It is a great responsibility and the resulting monograph shows that this has not been shirked. Much credit also goes to Sören Jensen's 'doctor-father' Stefan Bengston (Uppsala).

The monograph is beautifully produced with excellent illustrations set conveniently through the text. While the volume is of special interest to ichnologists it is an important work for sedimentologists and for evolutionary studies. Jensen really appreciates that trace fossils are sedimentary structures. Emphasis is given to the sedimentology and stratigraphy and to some of the sedimentary structures that are of doubtful origin or have often been interpreted as organic in origin. The latter include Eophyton, Aristophycus and Kinneyia. There is also a discussion on shrinkage cracks and deformed flute and load casts. The sedimentology of the Mickwitzia sandstone recalls particularly the Rhaetic of northwest Europe, likewise deposited in an epicontinental sea.

There are also several structures for which Jensen has not yet found an explanation. What caused the tool mark 'Eophyton'? And are the rather common *Spatangopsis* and *Protolyellia* inorganic or organic in origin? Jensen favours the former and will publish his evidence and views more fully elsewhere. But, as Seilacher & Goldring (1996) pointed out, it is easier to eliminate physical processes than to prove a biogenic origin. Unfortunately the only way available at present is to examine the field relationships in as much detail as possible and then to carry out destructive sectioning. Determining what kind of organism was responsible is the next stage. It is difficult but is a quite separate process. Most of the abundant material is in museums or private collections, separated from their sedimentological context. With such material it is not really possible to show whether or not it is of organic origin.

The trace fossils of the Mickwitzia sandstone are mostly distinct because of the low level of bioturbation. Besides the exquisite *Cruziana* and *Rusophycus* there are several ichnotaxa peculiar to the member. Although comparisons are always useful, it would be invidious to say that more might have been done by citing poorly understood ichnotaxa e.g. might *Olenichnus* Fedonkin, 1985 be a synonym of *Unisulcus* Hitchcock, 1858? What are the links between *Syringomorpha* (L. Cambrian), *Teichichnus* (Cambrian–Recent) and *Schaubcylindrichnus* (Jurassic–Cretaceous)? There is a particularly useful account of *Palaeophycus*, and also of *Diplocraterion* and *Rhizocorallium*. But *Rhizocorallium* has often been applied to skewed forms strongly affected by compaction and I would not altogether go along with Jensen's 'continuous morphological series' (Fig. 22). Further, sedimentation in the Mickwitzia sandstone did not favour the greater morphological detail available to Bromley & Hanken (1991) in northern Norway. Lower Cambrian *Diplocraterion* are all protrusive, with faecal pellets absent from the spreite. Perhaps a separate name should be used. Jensen appreciates that one type of animal might be responsible for several of the ichnotaxa, although no actual connections have been discovered. This is a job as much for the field as for the laboratory. As Jensen then adds, 'appreciation of trace fossils in biological and evolutionary studies must be strongly tempered'. The question may be posed: how can ichnodiversity be truly measured? Jensen is critical of the use of the lowest appearance of 'ready-made' *Phycodes pedum* to define the base of the Cambrian and it is likely that the whole boundary question will be reopened.

Roland Goldring

References

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SEILACHER, A. & GOLDRING, R. 1996. Class Psammocoralia (Coelenterata, Vendian-Ordovician): recognition, systematics, and distribution. *Geologiska Föreningens i Stockholm Förhandlingar* **118**, 207–16.

FONTBONTÉ, L. & BONI, M. (eds) 1994. *Sediment-Hosted Zn–Pb Ores*. Special Publication no. 10 of the Society for Geology Applied to Mineral Deposits. xi + 471 pp. Berlin, Heidelberg, New York, London, Paris, Tokyo, Hong Kong: Springer-Verlag. Price DM 298.00, Ös 2324.40, SFr 293.00 (hard covers). ISBN 3 540 56551 5.

This volume was compiled in honour of Professor Amstutz and presented to him on his 70th birthday. It includes 21 invited contributions from former students and colleagues who wished to demonstrate their appreciation and gratitude, by means of providing up-to-date syntheses for their main areas of research expertise. The overall brief was to consider both main classes of sediment-hosted Zn–Pb ores, the 'Sediment-Hosted Stratiform (SHS)' and 'Mississippi Valley-Type (MVT)' types.

Following from these initial precepts this volume is a great success. The papers included are integrated well together, clearly written and mainly excellent. They are grouped under sub-headings as follows: General aspects (5 papers); North American deposits (5 papers); European deposits (6 papers); Australian, Chinese and north African deposits (3 papers);

Exploration and economics (2 papers). Quite notably the papers indicate substantial agreement about most components of the ore genetic models concerned. Gize & Barnes consider it unlikely that the reduction of dissolved sulphates or metal sulphate complexes by organic matter caused significant deposition of lead and zinc. Spirakis & Heyl, however, point out that the role of thiosulphate may be vital, since this can be reduced at a sufficiently rapid rate by organic matter to provide sulphur for the precipitation of metallic sulphides. Very deep convection systems, which affect the basement, are no longer seen by Jones *et al*. and others, as necessary for the formation of SHS deposits, as these were formed in tectonically active rift or post-rift extensional basins, where geothermal gradients were high. For MVT deposits the long-established model of generation by lateral brine migration along aquifers in a compacting basin, has been to a large degree displaced by models of gravity driven fluid-flow due to tectonic uplift, or brine migration due to large-scale thrusting (noted in the papers by Symons & Sangster, and Kesler). The alternative name for SHS of 'Sedex' is still used by some authors, though as noted by Fontboté & Boni this can be misleading, as some of the deposits concerned are no longer considered to be formed by exhalative processes.

The standards of editing and presentation in the book are consistently high. The papers are fairly well illustrated with line drawings and a few plates. In just one paper some of these are in colour, and stand out a little oddly. The subject matter is specialized and thus the volume will be of greatest value to students at M.Sc. level or higher or to research workers.

G. M. Steed

GIAMBELLUCA, T. W. & HENDERSON-SELLERS, A. (eds) 1996. *Climate Change. Developing Southern Hemisphere Perspectives*. xii + 475 pp. Chichester, New York, Brisbane, Toronto, Singapore: John Wiley & Sons. Price £65.00 (hard covers). ISBN 0 471 96214 7.

Climate change is a massive subject; for the Southern Hemisphere the climate is not a matter for after-dinner talk, like British weather, but something that could mean drought and ruin for Australia, and worse for central and southern Africa and parts of Latin America, especially northeast Brazil.

This is a fine and important book giving the Southern Hemisphere perspective. The editors themselves live near, though not in, the areas that are likely to be most changed. Thomas Giambelluca is Hawaiian, Ann Henderson-Sellers is from Melbourne. The subject, like the mad cow debate, is one where frontier science meets political demands for instant answers. Henderson-Sellers is famous for her comments on SWINE (Scientists wildly indignant about nearly everything); it is easy to overstate the case, using results from very imperfect modelling to make dire predictions about major catastrophes. It is also easy to deny Cassandra, and to carry on regardless. The surer way is to adopt the Precautionary Principle: to hope all will be well, but to expect the worst and to take steps both to avoid it and to prepare for it.

The book treads carefully between politics and science. We hear much about the South, but where is the South? Beijing, the notional capital of the 'south', is north of Washington, capital of the 'north'; the southern nations Australia, New Zealand, Argentina, Southern Africa are more comparable to Canada, UK, Italy or Spain, and the Balkans than to Somalia. And even in the tropics there is sharp variety. Only a generation ago, Zimbabwean troops helped capture Rangoon, and defend poorer Malaya and Singapore; now Singapore, though on the equator, is to all other purposes a part of the 'north'.

To some extent, the divide is written in the fabric of humanity and the climate. The land is asymmetric, so too are humans. One of the great icons of atmospheric chemistry is the pair of 'flying carpets' – the graphs showing distribution of carbon dioxide and methane with time and latitude. All the obvious action is in the north; at the equator vast changes occur; the south is a smooth wave. But in other ways, the south and north are more similar than different. The same processes operate in both hemispheres, and people have the same behaviour, north and south: it is salutary to reflect that the colonial empires that remain at the end of the millennium are Indonesia (in Timor and New Guinea) and China (in Tibet).

The science in this work is impeccable, and well gathered in a coherent volume. This is a multi-author work, but it is also a fine general text on the diverse problems that global change is bringing to the tropics. In particular, everyone's nightmare is that ENSO events will become the norm. Walker, in the 1930s, was the first major scientist to worry about the impact of the Southern Oscillation on India: since then we have seen how the Walker circulation (El Niño/Southern Oscillation) events can devastate Africa, northeast Brazil and Australia. Will they become worse? How are they amplified if major volcanic eruptions deliver SO_2 into the stratosphere? We still only have partial answers.

Climate Change. Developing Southern Hemisphere Perspectives should be required reading by all politicians (especially Australian) involved in the thorny problems of negotiating controls to greenhouse emissions. It is an impressive contribution, not made by SWINE but by concerned yet careful authorities in the field. It is well worth reading, especially by geologists involved in the energy industry. Humanity needs oil, gas and coal, and we must provide it – if we did not, billions would starve – but we need also to be aware of the climatic consequences, and we need to think harder to find alternatives. There is plenty of catastrophe in geological history; it would be silly to deny Precaution.

E. G. Nisbet

SPARKS, R. S. J., BURSIK, M. I., CAREY, S. N., GILBERT, J. S., GLAZE, L. S., SIGURDSSON, H. & WOODS, A. W. 1997. *Volcanic Plumes*. xv + 574 pp. Chichester, New York, Weinheim, Brisbane, Singapore, Toronto: John Wiley & Sons. Price £85.00 (hard covers). ISBN 0 471 93901 3.

Volcanic activity near the Earth's surface almost invariably leads to the development of plumes. From the familiar towering columns of hot ash and pumice lofted high into the atmosphere by explosive eruptions, through the less obvious but no less important fountains of hot molten lava feeding diffuse rising thermals above basaltic volcanoes, volcanic plumes can be visually dramatic, and represent a key process in the transport of fragmented magma, pulverized rock, liquids and gases between the solid earth and the hydrosphere and atmosphere. Volcano-related plumes also extend to include the geysers and fountains of hot water and steam on land, and the 'smoking' hydrothermal vents beneath the oceans. The links between each of these kinds of activity are compelling: each is driven by the presence of a volcanic heat source, but, more importantly, the same general physical principles underpin the behaviour of all of these types of plume.

Sparks and his co-authors have been involved for many years with the development of experimental and theoretical models of

plume behaviour, with the goal of better understanding how volcanic systems behave, and their consequent effects. In this impressive volume they bring together much of this work, linking both the underlying principles with observations from nature and the laboratory, to present a state-of-the-art summary of present understanding of the behaviour of terrestrial volcanic plumes. Over the course of eighteen chapters the reader is taken from a general introduction to volcanism and fluid dynamics, through models for eruption columns, pyroclastic flows and associated ash clouds and geysers, to quantitative models of deposition from plumes. Later chapters cover the environmental hazards from plumes (both direct, when airborne; and indirect, from the deposits they leave behind), and their local and global atmospheric effects. The reference list is detailed and up to date, and the volume is thoroughly indexed. The scope is wide-ranging, although entirely focussed on the Earth, and will be of use not only to volcanologists, but to anyone interested in plumes in the natural environment and their effects. It should last as a key reference source for many years to come, and should be accessible to students and researchers from advanced undergraduate level and up.

David Pyle

DREW, L. J. 1997. *Undiscovered Petroleum and Mineral Resources. Assessment and Controversy*. xiii + 210 pp. New York: Plenum Press. Price US $59.50 (hard covers). ISBN 0 306 45524 2.

One of the more difficult tasks that geologists are sometimes called upon to do, is to predict (some would say guess) the amount of a geological material that may be found in the future in a given area. In this book Lawrence Drew, a long term US Geological Survey practitioner of resource assessment, sets out his ideas of how the process has been done by some in the USGS, attempts to explain why previous models of resource distribution have failed to accurately predict future finds and what is being done to improve predictions, and gives a warning about how any prediction may embroil the assessment team in controversy with not only other geologists, but also with politicians and the general public.

The introduction and first four chapters look at oil and gas in the USA, with examples drawn mainly from the Gulf Coast. The introduction sets the scene, stressing that predictions are not made in a vacuum, but are taken up by government, in some cases leading to conflict. Drew claims that disagreement over estimates of US ultimate oil and gas production, at least in part, lost one USGS director his job at the start of the Carter administration. Almost the same thing happened during the Reagan administration, when the USGS' pessimistic prediction of future gas resources was seen as conflicting with the government's plan to increase gas use.

Chapters 1 to 4 look at the 1980 forecast of the undiscovered oil and gas resources in the Gulf of Mexico and show how and why it failed to accurately predict what was eventually found. The 1980 forecast (for a particular area of the Gulf) predicted 217 fields with 1.78 billions of barrels of oil equivalent. In 1989 238 fields had been recorded, with 3.57 billions of barrels of oil equivalent. Not bad for field number, but about 100% off for volume. In part the difference could be explained by changes in the price paid for oil and gas, which made smaller fields more worthwhile, but much of the difference between prediction and reality could be explained by 'field growth', whereby many previously discovered fields had grown in size as development continued. Chapter 4 shows how the forecasters have attempted to modify their models to allow for field growth.

Chapters 5 to 7 look at forecasting of mineral resources, particularly in sensitive areas, such as those being assessed as possible wilderness areas. Users of the forecasts wanted predictions that included cash estimates, rather than the high, medium, or low resource potential, that was all many geologists were willing to give. Nor only did the methodology give rise to conflict, both within and outside the USGS, but the use of gross in-place value (GIPV) was seen as misleading by many critics as it ignored the costs of extraction, etc.

This was an interesting, though slightly frustrating, book to read. In places acronyms appear, only to be defined, if at all, pages later (for example GIPV is first used on page 140, but explained on page 165). Sometimes place names change between text and diagrams (for example White Point East is shown as White Point West on the first diagram where it appears). There were several places where I had to reread a section several times and am still not sure that I understand what Drew is trying to say. I got the impression, in these sections, that he was so close to the people and actions that he really could have used a total outsider to clarify his writing. But, leaving these problems aside, I would recommend this book to any geologist interested in resource forecasting, if only as a warning about how carefully defined and constrained predictions will be misused by anyone with an axe to grind. At $59.50 I doubt that many individuals would buy their own copy, but I would expect library copies to become well thumbed.

Antony Wyatt

RIGBY, S. 1997. *Fossils. The Story of Life.* 64 pp. Keyworth: British Geological Survey (Earthwise). Price £6.50 (paperback). ISBN 0 852722 84 2.

This is not a big book, but in just 64 pages Sue Rigby has managed to fit a comprehensive introductory account of modern palaeontology. This is not a text for higher education, nor was it intended to be: it is an attractive starter for anybody, of any age, who shows a germ interest in fossils.

The text is a pleasing mixture of 'classic' palaeo-nuggets such as information about major taxonomic groups, palaeoecology and the inevitable section on how fossils are formed, interspersed with more novel sections on the key events in the history of life (with a particularly British slant) and a number of case histories. The case histories cover the extraordinary breadth of palaeobiological endeavour and again emphasize (but not exclusively) British interests and more recent developments, with an eye for how palaeontology integrates with other branches of geology such as sorting out the terranes of the Southern Uplands and the use of isotopes from forams as palaeothermometers. It is perhaps a measure of the difficulty of simplifying of case studies that in the latter example it is only the complicating effect of ice sheet growth on isotopic ratios which is mentioned, rather than the fact that $\delta^{18}O$ always varies with temperature.

Once the appetite has been whetted, the book goes on to introduce the major British collections which can be visited by the public. The highlights of each museum are accompanied by a street map to locate them and details of their addresses and 'phone numbers. Such free advertising cannot go amiss.

If the book is let down, then it is by the final production. Covers often sell books, or at least get them picked up by browsers. Yet Earthwise have selected a curiously drab cover which certainly does not make the book stand out in any display. This is a real shame, because once opened the pages reveal generally excellent photographs of spectacular fossils and bright attractive colour drawings. However, here again, the book is let

down by a small number of photographs out of focus, such as what might have been a beautiful pyritized ammonite on p. 3 and the conodont elements on p. 48. Elsewhere some photos, e.g. *Eurypteris* and *Oxynoticeras*, are used twice. Whilst this may be forgiveable, the reversal of the negatives in the repetition of *Pikaia* (p. 7 or 32) and the fish *Naso* (p. 4 and 53) is less so.

This book could serve as an excellent introduction to palaeontology to anybody, in particular attracting school children to the subject. The publishers suggest that it is suitable for Key Stage 4 and A-level stage. Museum bookshops and others with an educational interest should stock up!

Liz Harper

MacGregor, A. R. 1996. *Fife and Angus Geology*, 3rd ed. xv + 291 pp. Edinburgh, Cambridge, Durham: The Pentland Press. Price £12.50 (paperback). ISBN 1 85821 353 3.

The soberly named *Fife and Angus Geology* (first edition 1968) will be familiar to anyone who has trodden the delectable rocks of those parts. Although about a quarter of the book is indeed devoted to a useful account of the geology of these counties, its value for more than a generation has lain primarily in the excellent descriptive itineraries of field excursions, mainly within easy reach of the author's bailiwick of St Andrews. In the third edition these follow substantially their predecessors, reduced slightly in number to 18 by incorporation and by the deletion of two – the Aberdeen/Stonehaven coast and South Queensferry – which are now adequately covered by other guides.

This above all a practical guide, of where to go and when (for tides), but the geological detail provided on exposures is judicious enough to provoke a tingle of anticipation even for those localities (such as Dura Den) described as 'worked out'. The emphasis is naturally on the superb exposures of sedimentary and volcanic rocks in the region, plutonic rocks (*sensu* H. H. Read) being represented only by Comrie and Glen Esk. The latter extraterritorial sally, although fine for the Highland Border series, is rather disappointing for the metamorphic rocks despite the promising map with isograds so optimistically delineated. (A more instructive, and longer itinerary is given in *The Geology of the Aberdeen Area*.) The author's neat sketches with their benign fine-weather skies figure appositely again but the printing of the plates is poor in comparison with the quality of the early editions. A useful addition is an index, while a sign of changing times and increased interest in geology is the code of geological conduct and proliferating warnings to obtain permission of landowners in advance of visiting many exposures. The A5 format is only slightly larger than the original hardback edition and with its soft cover is perhaps handier for a new generation to use and relish.

G. A. Chinner

Sabins, F. F. 1997. *Remote Sensing. Principles and Interpretation*, 3rd ed. xiii + 494 pp. New York: W. H. Freeman & Co. Price £32.95 (hard covers). ISBN 0 7167 2442 1.

Just the cover image of this large book should be enough to lure any geologist to peer inside. Lithological and structural information leap out from a stunning Landsat Thematic Mapper false-colour scene of part of arid southeast Colorado. While not overtly aimed at geologists, this introductory text on remote sensing and image processing makes such abundant use of geological case studies that it represents an excellent primer for geologists wishing to study the potential of remote sensing in this field.

The book opens conventionally with an introduction to the electromagnetic system, image forming systems, and data sources (usefully, with Web site addresses). Following chapters review the primary remote sensing tools: Landsat, SPOT, synthetic aperture radar (SAR), photography, etc. For each, the physical interactions between electromagnetic energy at the relevant frequencies and the surface and atmosphere are discussed, leading on to outlines of the design and operation of sensing systems, and finally the characteristics and interpretation of their data products. Throughout, geological examples are used, such as structural analysis in tectonically deformed terrains, lithological analysis of arid regions, and infrared measurements of volcanic thermal emission. Even SAR interferometry gets a mention, with reference to the recent work carried out in US and French laboratories concerning dynamic ground deformation associated with seismic and volcanic activity. Another section reviews results of the highly successful Magellan SAR mission of Venus. In each case, explanations of image processing or interpretation exercises take the reader logically through the steps required, with judicious reference to figures and worked examples. The bibliographies are extensive and contemporary, providing suitable inroads into the technical literature.

Later chapters cover some other applications of remote sensing in meteorology, oceanography, and natural hazard mitigation, and there are chapters devoted to remote sensing case studies in oil and mineral exploration, and to GIS and remote sensing integration in support of land cover mapping. The concluding chapter compares images from various spaceborne and airborne optical and microwave instruments acquired above the same site in Death Valley, California.

Figures proliferate on nearly every page, and benefit greatly from the large page format. The 28 pages of colour plates are superbly clear. In fact, the whole book makes good use of the room available – the eye soon alights on something of interest if one casually flips through the pages. Sabins' book is a classic in the remote sensing literature and will continue to be widely used both by established geologists requiring a specialist introduction to the field as well as undergraduate and graduate students: this third edition is the best yet. For its content, great clarity of style, and visual appeal, Sabins' book is hard to beat.

Clive Oppenheimer

Clarke, L. B. 1996. *Coal Prospects in Russia*. IEA Coal Research Perspectives Series, IEAPER/27. 50 pp. London: IEA Coal Research. Price £255.00 (non-member countries), £85.00 (member countries), £42.50 (educational establishments within member countries); paperback. ISBN 92 9029 275 X.

Baruya, P. S. & Clarke, L. B. 1996. *Coal Prospects in Latin America to 2010.* IEA Coal Research Perspectives Series, IEAPER/23. 76 pp. London: IEA Coal Research. Price £255.00 (non-member countries), £85.00 (member countries), £42.50 (educational establishments within member countries); paperback. ISBN 92 9029 266 0.

As part of their continuing update on coal prospects of various regions, the IEA Coal Research have published two new booklets on two of the World's most interesting and important coal regions. It has always been recognized that Russia was one of the coal-rich regions of the World. In addition, the old Soviet Union was one of the world's largest coal producers. Of the old Soviet Union, Russia's share of coal reserves and production is large. In recent years, however, the Russian coal industry has

been undergoing severe crisis. In 1988 Russia produced over 400 million tonnes of coal, which had fallen to just over 250 million tonnes by 1995. Much of the data on coal reserves and production in the literature referred to the old Soviet Union and obtaining reliable data on the Russian Federation has been difficult. The volume by Clarke has done the coal community a great favour. Following a useful introduction with an up-to-date map of Russian coal basins there is a discussion of the economic background. The chapter on energy supply and demand summarizes Russian energy resources. This chapter also considers the demand for coal and summarizes the major coal-fired power stations in Russia. In the chapter on Russian coal supply there is a detailed discussion of resources and reserves and even comments on coalbed methane. The current state and future of the mining industry organization is considered. Forecasts of Russian coal production show continued low levels of production to 2005 and then rising to the 1989 levels by 2025. This chapter also considers the restructuring and rationalization of the coal industry and the role of the World Bank. The huge constraints on the future profitability of Russian coal production caused by the problem of internal transport is considered in the following chapter. In a useful and challenging chapter the environmental issues are discussed. The table on principal environmental impacts identified in selected coal-producing areas of Russia by the World Bank is most useful.

In contrast to Russia, the coal industries of South America are small, but several are developing rapidly. Columbia is particularly significant in this regard. The volume by Baruya & Clarke considers coal prospects in all South American countries where there has been any coal reported. Following an introduction and regional overview, which reviews the factors affecting energy and coal prospects across Latin America as a whole, a number of countries are considered in detail. These include Argentina, Brazil, Chile, Columbia, Mexico, and Venezuela. This is followed by brief notes on many smaller countries including those of the Caribbean. The volume documents the rapidly expanding energy market in Latin America. For some countries such as Columbia, which has seen a rapid rise in coal production, for export in particular, there is a note of caution showing that expansion is limited by infrastructure constraints. This is important as Columbia is the most important coal producer and exporter in Latin America with the coal reserves also accounting for 75% of the region's total. The report concludes that coal prospects will improve as the need for energy and power in this dynamic region grows rapidly.

Both these volumes provide useful up-to-date data in a familiar format. For any department interested in fossil fuels these volumes will be an important addition to the Library.

Andrew Scott

BURG, J.-P. & FORD, M. 1997. *Orogeny Through Time*. Geological Society Special Publication no. 121. London, Bath: Geological Society of London. Price £59.00, US $99.00 (members' price £32.00, US $53.00); hard covers. ISBN 1 897799 75 6.

This volume contains nine papers from a seminar series at ETH, Zürich in 1994. Certainly I admire (and am rather jealous of) an institution that can put on a series of seminars on a theme using invited, international speakers. However, the book doesn't really work as a coherent and focussed attempt to provide 'greater awareness of the larger issues of orogenesis' (the stated aim of the seminar series, which may well have been more successful in that respect), in spite of a spirited and brave attempt to unify themes in the overview written by the editors.

The book starts with two discussions of lithosphere rheology, one, rather imaginatively, using observations of impact craters as 'universal drills' that penetrate continental interiors. There then follow six reviews of Precambrian and Palaeozoic orogenies in southwest India, northeast Australia, southeast Australia, the Caledonides, the Variscides and the Urals. Finally, there is a review of the Cenozoic evolution of the Andes. All the reviews are quite general and well illustrated, and will be useful reference works.

I suppose it is a matter of opinion whether a spectrum of contributions so heavily biased towards ancient orogenies and away from active modern ones will ever be able to provide a 'greater awareness of the larger issues of orogenesis'. That the present is the key to past is pretty deeply rooted in Earth Sciences, and it is at least an arguable point of view that our understanding of orogenesis advanced dramatically once people were able to use seismology, geodesy, geomorphology and a variety of other geophysical tricks to study mountain ranges *while they are active*. The contrary view that the big puzzles and questions are accessible in the old record, clearly implied in this book, seems curiously old-fashioned now, though it was perforce dominant until recently (and may be right).

The pedigree of this book, and its inclusion in the Geological Society's Special Publication Series, will ensure its place in libraries, but its price will make it unattractive to most individual researchers.

James Jackson

KIELAN-JAWOROWSKA, Z. & GAMBARYAN, P. P. 1994. *Postcranial Anatomy and Habits of Asian Multituberculate Mammals*. Fossils & Strata no. 36. Oslo, Copenhagen, Stockholm: Scandinavian University Press. Price US $29.00 (paperback). ISBN 82 00 37650 8.

Postcranial Anatomy and Habits of Asian Multituberculate Mammals is number 36 in the paperback monograph series 'Fossils and Strata'. Multituberculates are of perennial interest to palaeomammalogists and this study is both a timely and welcome addition to the huge corpus of literature on this most geologically long-lived group of mammals. Indeed the greater part of this body of work comes from the long career of the senior author. In 1995 Kielan-Jaworowska was rightfully honoured with the 'Romer-Simpson' medal of the Society of Vertebrate Palaeontology. This study is 92 pages in length, the first 40 pages given to an extremely detailed description of skeletal material from Taeniolabidoid multituberculates. Equally detailed muscle reconstructions occupy the 20 pages of the second part. Anatomical comparisons take up less than 10 pages, but the final 20 pages are a perceptive functional anatomical study of possible locomotor modes. Finally, a brief treatment of multituberculate habits and extinction is given.

The descriptive portions of the study are superbly done using very-high-quality black-and-white photographs of these mouse-sized remains. A great many of the photos are shown in stereo, and they are generally of a good size – often close to full page dimensions. Many features are clearly, yet unobtrusively, labelled with overlain numbers in the manner of the very best anatomical manuals. This said, it is a pity the superb stereo photos of *Chulsanbataar vulgaris* (Fig. 18) are reproduced at natural size. At least × 2 could easily have been accommodated, which would have done justice to superb photos of a beautiful little skeleton and skull. The few accompanying drawings are clear, accurate and pleasing. Measurements and morphometrics are explained at salient points with simple line diagrams.

The section dealing with myological reconstructions is extraordinarily detailed, with muscle scars mapped out so that origin

and insertion fields are well defined. In places where it was necessary to speculate about a scar or feature, this was clearly stated to be the case, thus leaving no doubt as to the basis for an assumption. There are of course inherent problems in reconstructing muscle arrangements in fossil material: in living forms some muscle attachments leave scars, others do not; yet no reconstruction is unreasonable, and comparisons with rodents and other small mammals (*Antechinus*, *Lepus* and *Elephantulus*) have been used as guides. Careful line drawings are used throughout, and it is pleasing to see the use of 'cross-sectional' reconstructions of putative muscle masses. Overall it is a brave, skilled and meticulous attempt, unlikely to be bettered. Having said that, there is one complaint against the layout of this section: the diagrams of muscle scars are not located adjacent to corresponding high-fidelity photographs of the item under consideration. This would have made possible a personal assessment of the evidence – and difficulties – more readily.

The third section is short and comprises a comparison of various Asian multituberculates with each other, Mesozoic mammals, extant monotremes and – a most pleasing addition – Triassic cynodonts. This is a very interesting short section and greatly aids in the physical visualization of how the multituberculate bauplan may have looked and operated in life.

The next section, on functional anatomy, is in the method of 'classical functional palaeoanatomy', based along lines of muscle action. It is naturally more speculative in essence than anything previous to it in the work, but the comparative anatomical basis that Asian multituberculates were all terrestrial runners is perfectly reasonable. The diagrams illustrating pelvis and hind limb movements in *Nemegtbataar* are very enlightening. That said, perhaps just a little in the way of applied engineering principles may have helped in this section, particularly with reference to scaling effect occurring in very small mammals.

A very short section (two and a half pages) lists plesiomorphies, synapomorphies and autapomorphies. A full cladistic analysis is clearly stated to be outside the scope of the paper.

The final stated aim of the work: a speculation into the habits and lifestyles of Asian multituberculates (and finally to the factors relating to their extinction), is covered in a brief three-page section that is concise, comprehensive and clearly reasoned. It is concluded that the studied Asian forms – unlike some North American genera – were not arboreal. Although different from living rodents, they were most probably like *Meriones* (the desert Jird) in their mode of life. The evidence suggests nocturnality based upon orbit size and the assumed *Meriones* way of life. From considerations of competitive inferiority and reproductive mode (viviparous with a very small neonate) it is concluded that the very narrow pelvis with its long immobile fused pubo-ischiadic keel (unique to at least these multituberculates) precluded them from the great reproductive advantage of a prolonged gestation open to Eutherians.

This is a superb study, and hugely advances our knowledge of Asian multituberculates – and beyond to other multituberculates generally. The text is excellent, the illustrations well conceived, and it is loaded with insightful information. This monograph is a 'must buy' for all serious palaeomammalogists.

Ian Jenkins

SARJEANT, W. A. S. (ed.) 1995. *Vertebrate Fossils and the Evolution of Scientific Concepts. A Tribute to L. Beverly Halstead*. xiii + 622 pp. Gordon & Breach. Price £78.00, US $120.00, ECU 100.00 (hard covers). ISBN 2 88124 996 5.

Beverly Halstead died tragically in a car accident in 1991. This edited volume was published as a memorial to the man and his indomitable spirit. Bev was a mercurial character in the fields of comparative anatomy, palaeontology, the history of science, histology, politics and philosophy, and was well known among us, and through the media more widely, as a tenacious controversialist. This volume has been compiled in part from papers which appeared in other journals, including *Modern Geology*, which Bev edited for the best part of eight years, and some new work specially prepared by the authors as a testament to Halstead's life and work.

Bill Sarjeant has performed stirling work in editing this large work; he has broken the papers up into seven sections. The first part contains reflections on Bev's life and work, including a thorough, and in places quite touching, biography by Bill Sarjeant himself. The remaining parts reflect the breadth of Halstead's work, covering, in order: Palaeozoic fishes, the history of the study of fossil reptiles, dinosaurs, vertebrate ichnology, fossil marine reptiles, and finally fossil mammals and faunal assemblages.

The papers contained within the various sections are best described as an interesting mixture, covering many disparate areas within the field of vertebrate palaeobiology in its widest possible sense. Many are small, rather specialized contributions, which inevitably make the volume something of an ecletic mix, of which, I have no doubt, Bev would have been proud – reflecting as it does his own philosophy. This is both its strength, and its weakness; for some the book may be only of interest because of a couple of articles, while others may wish to dip into it extensively over quite a long period of time. For example I found Bill Sarjeant's life of Beverly absolutely fascinating, and helped me better to understand the man who had at times charmed, flattered, cajoled and intensely annoyed but always impressed me with his passion (whatever the cause). I enjoyed Janvier & Bliek's paper on heterostracans, Buffetaut *et al*. on French dinosaurs, Hugh Torrens on 'Dinomania' and Helen Haste on 'Dinosaur as metaphor', Phil Currie's paper on ornithopod tracks from Canada, Tony Thulbourn & Sue Turner's contribution of pliosaur feeding, and Walken & Fraser's paper on fissure-fill sediments and environments. But ask any other vertebrate palaeontologist and the list would be entirely different.

Interesting the book is, without doubt, and clearly a tremendous editorial effort by Professor Sarjeant. However I am not sure who is likely to buy it. The mix and level of the articles are very variable; they do not form coherent elements that would enable one to use it as a teaching reference. It therefore has to be bought by those who are much more generally interested in the subject as a whole, and at £78 those with fairly large wallets. I cannot see many people actually stumping up the money for this and strongly suspect that the publishers see things that way as well, relying on low sales at a relatively exorbitant price, even though there were no author's costs or royalties to pay; of this, Beverly would most definitely not have approved!

David B. Norman

MÜLLER, D. & GROVES, D. I. 1995. *Potassic Igneous Rocks and Associated Gold–Copper Mineralization*. Lecture Notes in Earth Sciences Series, Volume 56. xiii + 210 pp. Berlin, Heidelberg, New York, Barcelona, Budapest, Hong Kong, London, Milan, Paris, Tokyo: Springer-Verlag. Price DM 98.00, Ös 764.40, SFr 94.50 (soft covers). ISBN 3 540 59116 8.

This is a valuable ore geology volume in its own right, and a most worthwhile contribution to the Springer-Verlag 'Lecture notes in Earth Sciences' series. At the start it is noted that the

work is two-thirds based on Müller's Ph.D. thesis, and this is reflected in the way it is presented, which is acceptable in view of the series' brief 'that timeliness of a manuscript is more important than its form'. The volume is soft bound, 210 pages in length, and adequately illustrated.

The title gives only a general indication of topics considered, in part due to the difficulty in providing a clear definition for 'potassic igneous rocks'. The authors choose the definition 'rocks with molar K_2O/Na_2O ratios of about or slightly higher than unity', which is hardly direct or obvious. They go on to exclude Group II kimberlites, lamproites and kamafugites, which do fit within their definition, for various reasons. It thus becomes clear that their main objectives are to deal with two very different associations:

(a) Potassic plutons in arc and within-plate settings and their associations with porphyry copper–gold and epithermal gold deposits. In this context the main interest is in Tertiary and more recent terrains, though older examples are also noted.

(b) Shoshonitic lamprophyre dykes and their direct and indirect association with mesothermal gold deposits, mainly within Archaean and Proterozoic terrains. This subject area follows on directly from the work of the late Dr Nick Rock, to whom the book is dedicated.

These topics are mainly dealt with by means of a series of well explained examples (e.g. Lodolam, Bingham, Grasberg, Tom's Gully, the Yilgarn Block). The information given is up-to-date and includes important results from the authors' recent research. This will be a valuable text for researchers on ore geology and for those concerned in the application of ore deposit models to mineral exploration.

G. M. Steed

BERGER, A. R. & IAMS, W. J. (eds) 1996. *Geoindicators. Assessing Rapid Environmental Changes in Earth Systems.* xi + 466 pp. Rotterdam, Brookfield: A. A. Balkema. Price Dfl. 165.00 (hard covers). ISBN 90 5410 631 X.

Bureaucratic institutions from the UN Environment Programme downwards generate a vast time-series of state-of-the-environment (SoE) reports, almost rich enough to warrant Fourier analysis. They are feedstock for the institutional gas-fests that masquerade as earnest concern for the world that we increasingly change. Can regulating economically-induced eco-change intervene rationally in a world economy out of control because of its own insane, yet iron logic of capital accumulation?

Finding a role for the geosciences in monitoring and predicting short-term environmental change presents a thorny problem if we are to match the political influence of climatologists and ecologists. Geology is fine for assessing past change, and there have been dramatic discoveries of upheavals from marine stratigraphy and ice-cap coring. But their rates of change are centennial and longer. Worrying, yes, but not sufficiently so to persuade politicians to act (as if they would).

Central to SoEs is the search for a swatch of natural indicators that play the role of the miner's canary. What is to be done if any such indicator gives the red alert for impending catastrophe is, of course, 'not science's responsibility'. Neither this book nor any like it pose the necessary questions that politicians too avoid like the plague. But these conference proceedings that address 'geoindicators' of rapid change, edited by Berger & Iams, have their own intrinsic usefulness. They examine basic physical geology to extract elements that do vary in the very short term. There is little about capital-induced changes of pollution and global warming. The focus is on processes that are natural but somehow hooked down the line into social factors. Main divisions are: glacial and periglacial environments: river systems and groundwater; marine and coastal environments; peat deposits; arid to semi-arid lands; and the human–Earth system interface in tropical landscapes and in cities. Each chapter's editorial preçis helps browsing and setting a context. The last third of the book abstracts theoretical frameworks for standardized monitoring, and ways to dip the geologist's oar into the edge of the political swamp.

Many of the papers stem from on-going research programmes, depending on the monitoring of changes both quantitative and in terms of quality. I get the impression that those which focus on geomorphic processes linked to the climate system are destined always to lag sufficiently behind events to promise only historical documentation of change. The drama unfolding about the pace of past climatic change from, for instance, uncalibrated but fine time-resolution logs of electrical conductivity in ice cores seems to indicate that what may be in store will be upon us before such monitoring can predict a change that needs to be heeded. None the less, this kind of monitoring can provide measures of risk to proposed human activities, a semi-quantitative input to planning. Of more immediate concern to the vast bulk of humanity are means of judging natural and anthropogenic changes in the quality of water and soil, on which health and indeed survival depend. Though touched on in several chapters, only two focus on these crucial issues.

The most appealing side to Berger & Iams' compilation is that it demonstrates with its broad scope the practical aspects of geomorphology and hydrogeochemistry, sufficiently to enrich a geoscience undergraduate curious about a career in a science with rapidly changing employment prospects.

Steve Drury

MIDDLEMOST, E. 1997. *Magmas, Rocks and Planetary Development. A Survey of Magma/Igneous Rock Systems*. xvii + 299 pp. Harlow: Addison Wesley Longman. Price £26.99 (paperback). ISBN 0 582 23089 6.

The remains of once-molten rocks coat the surface of our planet, and permeate its interior. Through their nature they hold clues – would that we could read them – to the past development and the present state of Earth's interior and, by extension, the interiors of other planetary bodies of our Solar System. This wide canvas is the igneous petrologists' playground. Within such a vast arena it is perhaps unsurprising, and certainly healthy, that petrologists come in different varieties: and 'what is it?' and 'how did it get there?' being the most obvious questions, petrologists can perhaps be divided crudely into taxonomists and processualists.

Middlemost has a long-standing interest in the systematics of the classification of igneous rocks. He is firmly of the view that the continuing confusion in igneous petrology stems from the 'inept or incorrect' naming of rocks. He is also convinced that a flaw of schemes currently in existence for classifying igneous rocks is that they may not account for the greater diversity of magmatic rocks across the Solar System. To some extent his concerns reflect the problems inherent in attempting to discover the relationships between the various solid, liquid and gaseous components in molten magmas, and the crystalline, glassy and fluid components that comprise their cooled equivalents. More fundamentally, Middlemost takes the view that it is not enough merely to adopt a scheme for classifying rocks that it based on the eighteenth century approach to Natural History (that is, to define and divide, and produce a scheme that is essentially convenient), since there will be little intellectual progress in the field until a genetic classification has arisen. Virtuous, no doubt;

but since arguments over classification seem to have changed rather little since Harker's time (Harker, 1909, p. 366) is this not a somewhat futile viewpoint?

Magmas, Rocks and Planetary Development promises, from its title, to be a broad perspective of the role of magmatism in the formation of and evolution of planetary bodies. In fact, it does no such thing. Subconsciously disregarding Morse's throw-away line about there being 'no free lunch in petrology' (Morse, 1986, p. 164). Middlemost presents the reader with a 'smorgasbord of information about igneous rocks'. Like the example of an 'all-u-can-eat' meal that this conjures up, the reader is led to gorge on minor delicacies while steering a course around a collection of more or less enticing dishes; some repeated from another part of the table; others flagging visibly; and still others looking uncomfortably out of place.

The book kicks off with a brief historical account of the 'magma/igneous rock system' (whatever that might mean!). Middlemost enjoys displaying his compendious knowledge, and this is frequently at the expense of following the most effective path to understanding. Exemplifying the approach, this account includes a list of fifteen publications that 'changed petrological perceptions' between 1950 and 1979, as a curious prelude to brief descriptions of 'isotopes', 'continents adrift', and 'extraterrestrial petrology'. Subsequent chapters stumble through classification, including the development of Middlemost's refined scheme for classifying silicate magmatic rocks; and thence to planetary interiors and planetary development. 'Partial melting and movement of magma' and the processes by which igneous rocks diversify receive a brief glance, before the final half of the book which introduces the principal sequences of igneous rocks. To illuminate 'the role of magma in planetary evolution' the closing chapter ranges from the Grand Unified Theory to the future of the Sun, as if to confirm the cosmic significance of igneous petrology. Throughout, Middlemost takes pains to distance this text from his 1985 book, *Magmas and Magmatic Rocks*, so that while there are obviously similar elements, *Magmas, Rocks and Planetary Development* is by no means simply a revised edition of the former.

It is perhaps too easy to criticize a notion with which one takes issue; nevertheless, one may take *Magmas, Rocks and Planetary Development* at face value and still find fault. I would hesitate to recommend this to be used as a textbook: too often, terms and concepts are introduced without explanation, or as asides, without the relevant context. A less ambitious, more focused enterprise might have yielded something more palatable (more flesh, fewer pips!) and, ultimately, more useful. Instead, the net result was to leave this reader with that rather uncomfortable sensation induced by incautious consumption: with some of the hunger sated, but a curious feeling that there's something missing.

David Pyle

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The history of geology, like geology itself, is subject to swings of fashion, when certain subjects attract special attention. Thus the 1970s witnessed a flowering of studies devoted to the geological philosopher Charles Lyell, while the 1980s (perhaps appropriately) belonged to the greater entrepreneur of the Silurian system, Roderick Murchison. Murchison's roles in several major controversies have been examined in great detail, and a fine study by Robert Stafford looks at his activities on behalf of empire. As a result, Murchison is now recognized as the most significant British geologist of his generation.

This book by Michael Collie & John Diemer discusses the early part of another major Murchisonian dispute, this time on the geologist's 'home ground' of Moray in northeast Scotland. The strata of the Elgin area, which had been identified on lithological grounds as Old Red Sandstone, were shown to contain fossil reptiles which had previously been identified as Triassic. Either the age of the rocks would have to be revised, or the first known appearance of reptilian life would need to be pushed further back into the geological record. The Elgin controversy proved of major significance for Victorian debates about the progressive history of life.

Collie & Diemer's account, which is based on extensive archival research, is useful in shedding some new light on Murchison's methods as revealed in his notebooks. The authors confirm that Murchison worked quickly, even hastily by the standards of contemporaries, and depended on skilled local observers. In many ways, they tell the first half of a story that – rather inconveniently – is continued in a different publication by Collie, *Huxley at Work* (1991).

The second half of *Murchison in Moray* is devoted to publishing in full the correspondence between Murchison and his principal local informant, the Rev. Dr. George Gordon of Birnie, together with several other documents. The letters are, with a few exceptions, rather dull and will interest only a handful of readers.

The narrative of the book's first half is sometimes hard to follow, partly because of a digressive style, and partly because of poor maps. Some of the illustrations are useful, however, and they include a fine, hitherto unknown, oil portrait of Murchison. The text contains many minor mistakes. It implies, for example, that Adam Sedgwick was a prebendary at Norwich in 1825, a position he assumed only in 1834; and Trenham Reeks appears variously as 'Trenham Rooks' and 'Tronham Rooks'. The authors frequently snipe at other historians, including myself, but most of the passages they cite as 'waspish' attacks on Murchison are actually attempts to convey how contemporaries viewed him. Surely the most effective role for history is not to refight old battles over reputation, but to understand them.

J. A. Secord

O'HANLEY, D. S. 1996. *Serpentinites. Records of Tectonic and Petrological History*. Oxford Monographs on Geology and Geophysics Volume 34. xiii + 277 pp. New York, Oxford: Oxford University Press. Price £72.95 (hard covers). ISBN 0 19 508254 0.

Serpentinites may be dismissed by many today as being merely altered peridotites and rather messy at that, but their extensive development in active zones has led at various times to their figuring prominently in geotectonic theories. Thus in pre-plate days the volume expansion of serpentinization was seriously considered as a cause of Mid-Atlantic Ridge formation, while within the plate era serpentine buoyancy has been invoked to enable the rapid ascent of blueschists and eclogites necessary for preservation of those high-pressure assemblages. Their potential to figure in future theory remains considerable, and of

course if we regard for this purpose serpentinized dolomite as one of the clan, serpentinites form the sole source of chrysotile, the one remaining commercial asbestiform mineral now socially acceptable. These then are good practical reasons for studying serpentinites, but the author, an enthusiast, makes no bones of the fact that he studies them for their own sake and his passion is patent in the questions he continually poses. The comprehensive character of his synthesis can be gathered from the headings of some of the 14 excellently illustrated chapters.

Serpentine group minerals considers the ranges of composition of lizardite, chrysotile, and antigorite, and examines their possible relative stability fields. *Patterns in outcrop* reveals subtleties of interpretation of serpentine in outcrops and even briefly explores the development of unique ecosystems (threatened, of course) on impoverished serpentine soils which act as a guide in remote sensing. *Textures in thin section* takes one into the world of pseudomorphic, hour glass and mesh textures, and the complexities of replacement of one serpentine mineral by another. *Hydration and serpentinisation of peridotites* addresses the problems of volume and chemical change in the serpentinization process. Three chapters deal with post-serpentinization processes: *Recrystallisation*, *Deserpentinisation* (progressive metamorphism) and *Metasomatism* (including rodingites, albitites and the pyroxene and amphibole jades). *Mineralisation* is a complex topic, the distinction between economic deposits inherited and those related to serpentinization processes not always being clear. Consideration of *Geochemical and geophysical data* leads directly to the genetic models of *Serpentinisation events and fluids*. Development of *Chrysotile asbestos*, although mentioned under mineralization, has a chapter to itself. *Serpentinites in their tectonic settings* ranges the gamut of serpentinites ancient and modern in their varied modes of occurrence. The final chapter, *Epilogue*, is less a summing up than a re-posing of questions raised throughout the book.

These chapter divisions are inevitably to some extent arbitrary and, despite the freshness of the author's approach, the reappearance of topics together with the range of phenomena to be synthesized can result in an undigested quality which does not make for easy reading. This is accordingly not a book which many will read straight off; but few geologists considering serpentinization will want to be far from a reference copy.

G. A. Chinner

NEKRASOV, I. YA. 1996. *Geochemistry, Mineralogy and Genesis of Gold Deposits*. xiv + 329 pp. Rotterdam, Brookfield: A. A. Balkema. Price Hfl. 150.00, US $85.00, £61.00 (hard covers). ISBN 90 5410 723 5.

This volume is the English version of Nekrasov's *Geokimiya mineralogiya i genezis zolotorudnikh mestorozhdenii*, originally published by Nauka of Moscow in 1991 and here translated by P. M. Rao for Balkema. The book starts with a brief chapter which attempts to outline the geochemical and mineralogical characteristics of the various types of gold deposits.

The second chapter deals in detail with the geochemistry of gold and there is also a welcome section on the broader chemistry of the metal. The geochemistry chapter is subdivided into three sections: gold in magmatic rocks; in sedimentary, metamorphic and metasomatic rocks; and gold in water and aqueous solutions. This chapter contains extensive tabulations of gold in rock analyses – the majority are from Russian localities and offer a valuable insight into the geochemistry of gold.

The mineralogy of gold is covered in the third chapter which provides descriptions of gold minerals, some 40 species in all. These include not only the gold telluride minerals but also many gold alloys and intermetallic gold compounds. Much mineralogical information is given for the individual species but locality data and references are rather restricted.

The occurrence and genesis of gold in quartz veins is discussed in Chapter 4. Fluid inclusion data on gold-bearing quartz veins is included and this leads into an extensive discussion of the solubility of gold in aqueous chloride-bearing solutions. The section dealing with the solubility of gold in aqueous solutions contains extensive tabulations of thermodynamic and solubility data. Phase relations in the gold–sulphide systems are the subject of long and detailed discussion presented in Chapter 5. This chapter also contains an extensive discussion of the occurrence of gold with the antimony and bismuth sulphide minerals (it is a pity that Sb_2S_3 is referred to as antimonite rather than stibnite throughout). Chapters 6 and 7 deal with phase relations in the gold–arsenic and the gold–selenide and gold–telluride systems and again contain extensive tabulations of thermodynamic data and many phase diagrams. The final chapter returns to a discussion of the geochemical features of gold deposits and their relationship to ore genesis.

The publisher has done a great service in bringing out an English translation of this very good Russian book. The book is, however, hard to read, a product of both the writing style (which is rather stilted) and the typeface used, and unfortunately the book is marred by a considerable number of typographical errors which I am sure closer editing could have eliminated. Overall the book contains a wealth of information for those interested in the geology of gold and the price, given that the volume has been published in a well bound hardback edition, is reasonable. I recommend the book to those with a strong interest in the gold mining industry.

Allan Pring

STAR, J. L., ESTES, J. E. & MCGWIRE, K. C. (eds) 1997. *Integration of Geographic Information Systems and Remote Sensing.* Topics in Remote Sensing Series no. 5. xvii + 225 pp. Cambridge, New York, Port Chester, Melbourne, Sydney: Cambridge University Press. Price £35.00, US $49.95 (hard covers). ISBN 0 521 44032 7.

In several respects, remote sensing and GIS are complementary technologies. Remote sensing can provide the data needed to update a GIS, while GIS can facilitate and enhance the interpretation of the remotely sensed data. The fusion of GIS and remote sensing has come to be known as the field of Integrated Geographic Information Systems (IGIS). A working IGIS contains 'layers' of spatial information from diverse sources – perhaps maps, satellite images, geochemical data, and digital elevation models. An important aspect of the system is that all the layers are related to each other spatially. This book developed out of a programme of research activities conducted under the auspices of the National Center for Geographic Information and Analysis called Initiative 12, 'The Integration of Remote Sensing and GIS', whose goal was to 'create a prioritised research agenda to remove impediments to the fuller integration of remote sensing and GIS'. This multi-authored text, the fifth contribution from the Cambridge University Press 'Topics in Remote Sensing' series, provides the background to the Initiative, and probes some of the techniques, applications and challenges of IGIS.

After an introductory chapter on Initiative 12 by Star *et al.*, Ehlers reviews the basic principles of geometric rectification and registration of different datasets to a common geographic coordinate system. This, of course, is the fundamental preliminary step in building an IGIS. Next, Jensen *et al.* consider the

extraction of change detection information from remotely sensed datasets, examining issues of resolution and atmospheric corrections, and comparing various change detection algorithms. In Chapter 4, Faust & Star describe and give examples of visualization of multi-dimensional datasets – these range from surface rendering (for example, perspective views of a satellite image draped over a digital elevation model), to display of hyperspectral data, to flight simulation. Of course, building and displaying the database is rarely the ultimate aim of an IGIS project. The next step is likely to be intensive modelling of the data according to the desired objectives of the project. Computational Modelling Systems (CMS), which are designed to increase the efficiency in the development and application of scientific models, can also facilitate the integration of data and software in IGIS analyses. In their chapter on such systems, Smith *et al.* present the workings of a hydrological CMS used to model water flow in river basins.

Chapter 6, authored by McGwire & Goodchild, explores the difficulties of tracking errors in IGIS. These accumulate in complex ways because of the diverse nature of the spatial datasets used and their variable positional or thematic accuracy. The issue is taken up in a discussion on data standards in the following chapter by Foresman & Millette which concentrates on the particular needs of planners. Next, Asrar moves the focus from the neighbourhood scale to the global scale by outlining the background and objectives of NASA's Mission To Planet Earth programme (MTPE), and discussing the evolving requirements of GIS for global change research and policy making. The chapter reviews the operational sensors contributing to the mission as well as the future satellites due for launch, notably the centrepiece of NASA's MTPE activities, the Earth Observing System series. Estes & Star conclude the book by looking to the future of IGIS. They promote a research agenda for future IGIS development which they see as 'a living document that will help guide institutions, organizations, and individuals in the future as they fund, propose, and/or conduct research in remote sensing/GIS integration'.

The text is clearly written throughout and is adequately referenced and indexed. Unfortunately, some of the illustrations are poorly reproduced – particularly those in black and white – or too small to make much of. Too many figure captions are curt to the point of failing to convey anything useful. As a whole, this is an eclectic work, mixing as it does deep musings on institutional issues for IGIS evolution with material that would not be out of place in an introductory text on remote sensing or digital image processing. While geologists interested in learning more about IGIS will find much here that is informative, they will almost certainly wish to skip over the sections elaborating on the Initiative 12 workshop reports and research agenda.

Clive Oppenheimer

HOFMANN-WELLENHOF, B., LICHTENEGGER, H. & COLLINS, J. 1994. *Global Positioning System. Theory and Practice*, 3rd ed. xxiii + 355 pp. Wien, New York: Springer-Verlag. Price DM 79.00, Ös 550.00 (soft covers). ISBN 3 211 82591 6.

This is the third edition of a volume first published by these authors in 1992. For those unfamiliar with the earlier editions, this is a comprehensive text on the Global Positioning System (GPS) written principally from a surveying and geodesy perspective. This comment is made to emphasize that the book is slanted towards the acquisition and processing of the data, and the mathematical techniques that are required to obtain the highest possible accuracy from the use of the system. The use of GPS within the context of navigation and for low accuracy applications with inexpensive receivers is also within its scope. What it does *not* cover is areas such as the electronics of receiver design, and so on.

The first third of the book covers the essential background material, including an overview of the system, the reference systems for coordinates and time, orbital theory, the satellite signal, and the different types of observation that may be made of the code or the phase of the signal.

The major part of the rest of the book is then concerned with the practical and theoretical aspects of turning these raw observations into coordinates that are of significance to the user. This mostly means covering the mathematical models, the data processing, and the software, but also includes the problems associated with the use of local datums of lower accuracy as well as height problems related to the geoid.

The final two chapters cover the applications and the future of GPS. These sections are ones that will date more rapidly; the strength of the book as a whole lies, however, in providing a grounding in the theoretical and mathematical modelling aspects of the subject. This is something that it does well, and it can be recommended as a good reference text with a reasonably long shelf life, providing a background to more up-to-date but ephemeral literature.

J. C. Iliffe

HYMAN, M. & ROWE, M. W. (eds) 1996. *Advances in Analytical Geochemistry, Volume 2*. x + 344 pp. London: JAI Press. Price £69.50, US $109.50 (hard covers). ISBN 1 55938 785 8.

This is the second volume in a series of review articles aimed at providing in-depth accounts of analytical techniques for scientists involved in geochemical and related studies. The targeted readers are post-graduate students, post-doctoral researchers, industrial chemists and those teaching undergraduate geochemistry courses.

This second volume comprises six chapters, the first of which by Trevor R. Ireland is everything a good review should be. It is an authoritative account describing in detail the instrumentation, theoretical aspects and methodology of Ion-microprobe Mass Spectrometry. Applications of the technique are diverse and are fully covered in the chapter and backed up with an extensive reference list. The author's grasp of all the aspects of the technique comes through strongly, and the whole chapter is presented in a stimulating manner with well-written text, clear diagrams and a sense of enjoyment.

It is a pity that the following chapters in this volume do not achieve the standards set by the lead chapter by Ireland.

Chapters 3 and 5 on the specialist techniques of solid state NMR (by Jarvie & Mueller) and GC-combustion-IRMS (by Routh & Cifuentes) respectively, although adequately treated, are not particularly inspiring to the reader.

Chapter 4 entitled 'Multivariate Statistical Techniques for Trace Element Analysis' (by Wolf & Lipschutz) is a useful introduction to this topic, and is illustrated using examples from cosmochemical and botanical studies to discriminate sample populations.

Chapter 2 on Microanalytical Laser Extraction of Noble Gases (by Nichols Jr., Kehm & Hohenberg), although an adequate description of the laser techniques, fails to provide a detailed theoretical treatment of the detection and measurement of the noble gases themselves. Also evident is the limited extent of potential applications, these apparently being confined solely to cosmochemical studies. (Are there any terrestrial examples of applications for this technique?)

Also disappointing was Chapter 6 on Mössbauer Spectroscopy (by Berry) which appeared dated in its treatment of the subject, both in the instrumentation and the applications. The references cited were limited in their scope, and were underrepresented by recent publications on geochemical applications where much exciting work on elements other than iron is being undertaken.

There is a strong extra-terrestrial flavour to this volume with three of the six chapters focusing on applications from meteoritic and cosmochemical studies. This of course reflects the authors' main research interests, but in at least one of those chapters, this approach becomes too parochial for a general review chapter and indeed limits the appeal of the technique itself. The overall production of the book merits a mention: the almost sepia-coloured pages and the often poor quality reproduction of even line diagrams (inexcusable with modern printing techniques and apparent also in the first volume of the series) gives a dusty, old-fashioned feel to the book. Although JAI Press have generally a good reputation for publication of good quality text-books, in a competitive field significantly more effort is needed in the production stage to make the series at least more visually appealing, in order to maintain their reputation. The major criticism of the first volume of the series, that of an uneven quality to the book, is still valid. However, there is still a clear need for a modern review series such as this and if the editors can convince JAI at least to modernise also the design and production for future volumes, then this series will meet the requirements of the targeted audience.

C. T. Williams

YOSHIDA, M. & SANTOSH, M. 1995. *India and Antarctica During the Precambrian.* Memoir 34. xvii + 412 pp. Bangalore: Geological Society of India. Price not stated (paperback). ISBN 81 85867 16 X.

Fifty years ago, India was fertile ground for new ideas in geology. Gondwana is Indian to the core; one of the best of the early papers that were precursors to plate tectonics is the essay by Sir Lewis Fermor given in Zimbabwe on his return from India in 1947. This volume picks up some of those threads. Yoshida & Santosh have put together a fine collection of Indian and international papers, with the linking theme of the assembly of Gondwana in the Proterozoic.

The subjects discussed include Gondwana's tectonics, metamorphic history, fluid processes, structure, geochemistry, geophysics, magmatism, mineralization and geochronology. There are 24 papers, some from Indian authors, other authors are from the USA, UK, Japan, Australia, Netherlands. This diversity shows the width of interest and cover; although this is very much a conference volume, nevertheless the volume does keep coherence and focus.

The quality of many of the papers, both from Indian and international contributors, is generally high, and several papers address subjects that are of global rather than local interest. For any department whose interests are in shield areas, this is a volume well worth acquiring.

E. G. Nisbet

PETERS, E. K. 1996. *No Stone Unturned. Reasoning About Rocks and Fossils.* xiii + 237 pp. New York, London: W. H. Freeman & Co. Price £14.95 (paperback). ISBN 0 7167 2953 9.

Here's a brave attempt to show undergraduates that science has as much to do with personal foible as with impersonal objectivity. *No Stone Unturned* will annoy teachers who lay great store by The Scientific Method. Some sciences are methodical, others wildly eclectic. Ultimately, neither carry any burden of proof, and Karl Popper's notion of falsification and the empiricists' evidential obsession with 'the facts' are as problematic to science as they are to the vast majority of philosophers.

This challenge of reality to dogma, as in all branches of culture, is amply shown by the continual upheaval in scientific ideas. Even the thoroughly pragmatic and quintessentially American notion of T. C. Chamberlin that science must juggle and test multiple working hypotheses fails to match up to actuality. Hypotheses may have their ultimate source in the material world, but they spring imperfectly from thought, its history and traditions and a whole concatenation of thoroughly human assumptions about our milieu. Peters concludes that science is driven by simple curiosity and advances by polemic, no matter that debate is sometimes blinkered, coloured by prejudice, confusion and even downright fraud. It all works out right in the end.

That might seem a reasonable view, a human view, were it not for the inescapable reality that science-as-curiosity is harnessed to the inhuman demands of capital's self-accumulation. It is not yet free, but grossly distorted, in the same manner as all other branches of culture. That is a view that does not figure in E. K. Peters' personal account of the geosciences.

Starting with a philosophical framework, we are loaded for bear, for Neptunism and Plutonism, Gradualism and Catastrophism, and for Charles Lyell and Walter Alvarez. The interplay between the gradual and the awfully sudden is the central theme of the rest of *No Stone Unturned.* It is gleefully illustrated by overspill floods from ice marginal lakes (the channelled scablands of Washington State), by sea-floor spreading, mass extinctions and punctuations in biological evolution.

The evolution of geological ideas – equally characterized by gradualism and disturbing upheaval – and the parallel ones about life's origin and course, have been bad news for god-worshippers. That theism still clings on bears witness to questions that science, at any stage in its development, finds it difficult to answer fully. Peters summarizes many of these 'big questions', from the circularity inherent in 'the survival of the fittest' to the seeming improbability of life and indeed the planet and universe of which it is a part. They, as always, nourish the debate between the fundamental standpoints in philosophy of idealism and materialism. It is on this note, illustrated by the creationist–evolutionist pseudo-debate in the USA and other fundamentalist circles, that the book concludes.

Though it fails to recognise the greatest unturned boulder, that of science's current political–economic context, *No Stone Unturned* is extremely valuable. While most Earth Science texts fastidiously dispose of debate and philosophy in an early page or two, E. K. Peters provides an expansion for beginners in her subject on which thoughtfulness can blend with curiosity about the world.

Steve Drury

BANDA, E., TORNÉ, M. & TALWANI, M. (eds) 1995. *Rifted Ocean–Continent Boundaries.* NATO ASI Series C, Mathematical and Physical Sciences, Volume 463. xviii + 387 pp. + map. Dordrecht, Boston, London: Kluwer. Price Dfl. 260.00, US $185.00, £117.00 (hard covers). ISBN 0 7923 3505 8.

Academic studies of rifted continental margins and of the transition zone between continental and oceanic crust have been subordinate in recent years to studies of more active processes on

mid-ocean ridges and at the seabed, yet here is a volume that demonstrates to the reader the recent progress in, and wide range of, this lively subject. As hydrocarbon exploration extends into increasingly deeper water it seems evident that the value and relevance of fundamental studies of the rifting and break-up of continents should receive wider support but this has yet to materialize in any form of focused national or international programme.

This book is a collection of papers that records the talks given at a NATO Advanced Research Workshop attended by 36 scientists, many of them renowned experts in their field, in Mallorca in May 1994. The group spent four days in seminars, poster sessions and general discussions covering the broad range of topics described here.

The majority of the contributions can be grouped into a small number of topics. The book opens with a collection of chapters that apply theoretical methods to studies of melting in the asthenosphere (Keen & Boutilier, Bown & White), the stress regime accompanying rifting (Bott) and the flexure of margins by sediment loading (Watts & Marr). The two papers on melting present the two fundamental differences of approach, still unresolved, that have been used to explain the existence of volcanic rifted margins and in particular the seaward dipping reflector sequences and subcrustal melt accumulations that characterize them. Is the unusually high melt production the result of relatively small scale convective flow beneath a rift or is it the product of more deep seated adiabatic melting enhanced by abnormally high asthenospheric temperatures?

A second group of papers deals with direct observations on volcanic margins. Eldholm *et al*. even suggest that such margins may be the normal case as opposed to the non-volcanic or amagmatic variety. They critically review the assumptions that are often made when building models of volcanic margins. Skogseid & Eldholm then review the extensive information available from academic research and industry concerning the structure of the Norwegian margin. Talwani *et al*. focus on the enigmatic East Coast Magnetic Anomaly that has puzzled students of the eastern margin of the USA for many years. They come to the conclusion that it is caused by seaward dipping reflectors that are separated from the underlying mantle by intrusive melt products.

Discussion of the mantle under the continental margins brings us to the third group of papers that deals with the West Iberia margin (the 'home' of the unroofed mantle concept), currently the most thoroughly investigated, and possibly even the best understood, rifted margin anywhere. Four papers by Sibuet *et al.*, Boillot *et al*., Krawczyk & Reston, and Torné *et al*. concentrate on different aspects of the West Iberia margin. Using geophysical data Sibuet *et al*. convincingly demonstrate the significance of the peridotite ridge off Galicia Bank as a marker of the landward edge of oceanic crust. Krawczyk & Reston present data in support of the contention that the S reflector beneath Galicia Bank represents a late detachment fault not offset by the normal faults associated with the overlying fault blocks. In the southern part of the Iberia margin Torné *et al*. use geoid, gravity, heat flow and elevation data to show that thinning of the continental crust was achieved principally at the expense of the lower crust. Finally Boillot *et al*. review work carried out over a period of years on the Galicia Bank margin and map out a general strategy for further work. They emphasize the very great importance of obtaining samples of basement rock. Because of sediment blanketing such samples are a luxury not commonly available yet they are something to which all investigators of rifted margins should aspire whether they are obtained by dredging, submersible sampling or even by ocean drilling.

The remaining chapters in the book cover a range of assorted subjects such as back-arc rifting (surely the tectonic and even magmatic parallels between such rifting and rifted margins deserves closer study), the possibility of very slow seafloor spreading off southwest Greenland, the Ivory Coast–Ghana transform margin, transtensional rifting in the Marmora Sea and early rifting in the Valencia Trough (an example of incomplete continental rifting), which brings us back to Mallorca where this review began.

This book provides a snapshot of a subject that has continued to evolve rapidly since the meeting took place. Nevertheless it contains some stimulating reviews and presents results from a wide range of rifted margins. Continental margin studies will continue to progress by a combination of the application of theoretical methods to studies of the rifting and melting processes as well as by direct geological and geophysical observations. Among these should be counted sampling by submersible and drilling, where practical, and the application of seismic (both reflection and wide-angle) and other geophysical methods backed up by the most sophisticated processing techniques available. A special plea should be made too for the study of conjugate pairs of margins not one example of which can be found in the present book.

Bob Whitmarsh

FRENCH, H. M. 1996. *The Periglacial Environment*, 2nd ed. xxxiv + 341 pp. Harlow: Addison Wesley Longman. Price £22.99 (paperback). ISBN 0 582 30536 5.

It is over twenty years since Hugh French wrote the first edition of *The Periglacial Environment*. In that time it has come to be regarded as one of the seminal texts on periglacial geomorphology, although in recent years it has begun to appear somewhat dated. The second edition of this book reflects the fact that significant advances have been made in the discipline during this time and that a huge volume of new literature has been produced in the intervening period. The overall level, scope and organization of the second edition do not differ radically from the first edition, although many chapters in this second edition are new and some appear to have been entirely rewritten. The second edition also benefits from the addition of a new section concerning applied periglacial geomorphology.

The book is divided into four parts. Part 1 (The periglacial domain) serves as an introduction to the topic and includes three chapters covering the definitions, landscapes and climates of periglacial areas. Part 2 (Present-day periglacial environments) forms the bulk of the book and contains 9 chapters. These are mainly process-orientated descriptions and discussion of the principal cryogenic processes. Topics covered include frost action and cryogenic weathering, permafrost, ground ice, thermokarst, the active layer, hillslope processes, slope morphology, fluvial processes and landforms, wind action and coastal processes. In Part 3 (Pleistocene periglacial environments), French considers the operation of these processes in the recent past. Three separate chapters cover the reconstruction of periglacial conditions, relic periglacial phenomena, and the role of wind action, tundra rivers and periglacial landscape modification. Part 4 (Applied periglacial geomorphology) comprises two chapters that open the book out into a discussion of the wider geotechnical and engineering aspects of living and working in periglacial terrain, as well as considering the possible effects of global change on the periglacial environment.

The internal structure of each of the 17 chapters is clear and logical throughout the book. Each chapter is prefaced by a short 'abstract' outlining the main points and issues to be discussed. There then follows a brief introduction, the text of the chapter

itself, and a conclusion summarizing the main points. In addition each chapter also contains a guide to further reading (usually containing 7–10 references to salient journal articles) as well as two or three discussion topics arising from the text. The discussion topics are a useful teaching aid designed to test understanding of the topics covered and, together with subsidiary reading, these could form the basis of a tutorial or seminar. The second edition cannot be faulted on its presentation. The text is clear and well written. The main points and concepts are illustrated with good black-and-white photographs and diagrams, and the reproduction quality of both photographs and diagrams is good throughout. The reference list runs to 30 pages and there is a comprehensive index.

This book is aimed firmly at the undergraduate market, particularly at second and third year geography students. At £22.99 for paperback it is also sensibly priced. I have no doubt that it will serve their purposes well, although there is a tendency to draw heavily on North American and Eurasian examples in the present-day process parts of the book. This is compensated for in the three chapters covering Pleistocene periglacial environments, where numerous European examples are cited. The European (and particularly the British) market is also well served by the recently published book by Ballantyne & Harris (1994) and comparison between these two books is inevitable. Probably the most significant difference between the two is their geographical focus. French tends to concentrate on high-latitude processes and landforms, whilst the strength of Ballantyne & Harris's book lies in its treatment of the periglacial processes and landforms of alpine areas. There is no doubt that there is room for both in the undergraduate market. My own feeling is that French's book provides a better general introductory periglacial text, whilst that of Ballantyne & Harris is more specialized in its content and is more comprehensive in its descriptions and treatment of the literature.

In the Preface to this second edition, French states that the book has two aims. The first is to give a realistic appraisal of the nature of geomorphic processes and landforms in high-latitude periglacial environments. The second is to provide a guide to the recognition and interpretation of periglacial features in the now temperate regions of North America and Europe. If the success of a book is judged against its explicit aims, then there can be no doubt that this book is a success.

Neil F. Glasser

Reference

BALLANTYNE, C. K. & HARRIS, C. 1994. *The Periglaciation of Great Britain*. Cambridge University Press.

WADIA, S., KORISETTAR, R. & KALE, V. S. (eds) 1995. *Quaternary Environments and Geoarchaeology of India. Essays in Honour of Professor S. N. Rajaguru*. Memoir 32. xx + 552 pp. Bangalore: Geological Society of India. Price not stated (paperback). ISBN 81 85867 17 8.

Books on the Quaternary of India are rare and books on the Quaternary of India in an archaeological context are rarer still. But then, the scholar in whose honour this work has been written by a large group of his former students, colleagues and admirers was clearly a man rare in the breadth and depth of his interest and in his knowledge of the Quaternary of India.

Inevitably, a work of this kind is like a multi-cultural smorgasbord; offerings of many kinds for many interests sit side by side and its total impact cannot be judged by any single individual. Together they are better suited to whet the reader's appetite than satisfy the searcher's need for specific information regarding the later Quaternary of India. For similar reasons it is also very difficult to review.

The work is divided into many sections. After a tribute to Professor Rajaguru, a section on the climates and palaeoclimates of the broader Asian region ranging from the middle Cenozoic to the present opens the book. The next four sections are regional in concept, covering Upper India and the Himalayas, western and northwestern, central and peninsular and coastal and offshore India. Geomorphology, palaeopedology, sedimentology, sea level studies and several articles on the Palaeolithic appear here side by side, and I found personally much of interest and much to be admired in the contents.

A section uninformatively labelled 'Methods and Results', which contains primarily archaeological materials, forms the rearguard. In addition, there are two bibliographies of interest, one covering the lifetime publications of Professor Rajaguru, the other a list of the Ph.D. dissertations completed under his direction.

Some fifty authors, Indian and foreign, among them many well-known names, have contributed to a work that, variable and almost confusingly diverse as it is, still offers a useful introduction to its subjects. Any library counting the Quaternary of Asia among its domains should have a copy of it on its shelves.

Tjeerd H. van Andel

WOOLFSON, M. M. 1997. *An Introduction to X-Ray Crystallography*, 2nd ed. xii + 402 pp. Cambridge, New York, Port Chester, Melbourne, Sydney: Cambridge University Press. Price £65.00, US $90.00 (hard covers); £22.95, US $37.95 (paperback). ISBN 0 521 41271 4; 0 521 42359 7 (pb).

Michael Woolfson's classic book on x-ray crystallography first appeared in 1970, but has been out of print for many years and sadly missed by many in the crystallography community. Thankfully, we are now blessed with a handsome, expanded second edition. Although much of the first edition has been retained, the new edition has been brought bang up to date with modern crystallographic techniques, including synchrotron x-ray diffraction, and structure refinement from x-ray power diffraction. The other major change is an appendix listing a number of FORTRAN programs to illustrate crystallographic concepts.

This is a very detailed book, aimed at final-year undergraduate, or graduate students, or researchers. There is a high mathematical content, but equations are derived step-by-step, and the methods well annotated. The quality of writing is also very high, and the casual reader should find this an inviting and rewarding book. Exercises at the end of each chapter should facilitate self-study, and solutions (including helpful comments!) are to be found at the end of the book.

The book begins by instilling a sense of wonder at natural crystals – minerals – pondering the origins of their smooth faces and precise angles. The 'point symmetry' of such single crystals has its origins deep in a crystal's internal structure, relating to the 'space symmetry' of atom arrangements in unit cells of the crystal's lattice. As this sub-microscopic world is revealed, we are introduced to a basic crystallographic vocabulary, including crystal classes and systems, lattice planes/vectors and Miller Indices, followed by an introduction to plane- and space-group symmetry.

After a short but well-illustrated chapter outlining the physics of the scattering process, scattering from real crystals is analysed. Woolfson uses a clear, physics approach, starting with a simple 1D model, and extending this to the 3D case, to illustrate the concept of a 'reciprocal lattice' and the use of 'Laue

Equations' to predict diffraction maxima. Having explained diffraction at a basic level of 'point scatterers' in 3D, he next uses a more sophisticated, Fourier Transform approach to look at the process in more detail, e.g. replacing point scatterers by an electron density function.

Theory complete, we now look at experimental crystallography, and the techniques used to record x-ray diffraction. Single-crystal film techniques (Oscillation, Procession and Weissenberg Cameras) are explained, with direct reference to the 'reciprocal lattice'. Diffractometers and x-ray power cameras are also described. The generation of x-rays is detailed, starting with traditional lab-based x-ray tubes (including rotating anode sources), and leading to a new section of synchrotron x-ray sources. Finer details of x-ray scattering are covered in the next chapter: diffraction from a rotating crystal, absorption of x-rays, primary and secondary extinction, the effect of the atomic vibrations (temperature factors) and anomalous scattering.

The last three chapters are more applied in nature, beginning with ways to determine space groups (e.g. the presence of a centre of symmetry, and optical properties), leading to recipes for the actual determination of crystal structures (use of the Patterson Function; Heavy Atom Replacement; etc.). Worked examples are used throughout these sections. Finally, a short cautionary chapter on accuracy and the refinement process.

An appendix contains 37 pages of FORTRAN program listings. The programs are designed as examples, and are designed to illustrate 1D and 2D examples, rather than full 3D structures solutions. For those interested in using the code on their own computers, the book does include a web address for downloading source code files! Although the code is extensively annotated, the programs are written in an antiquated, non-indented 'spaghetti FORTRAN' that many readers will find intimidating. There is no excuse for such badly structured and presented code: modern FORTRAN compilers can easily cope with lowercase characters, statement indentation, and rarely, if ever, require the use of messy 'GOTO' statements!

Despite my misgivings about the FORTRAN examples, I am delighted to welcome back this authoritative and highly readable textbook.

David C. Palmer

DODSON, P. 1996. *The Horned Dinosaurs. A Natural History*. xiv + 346 pp. Princeton: Princeton University Press. Price US $35.00 (hard covers). ISBN 0 691 02882 6.

The Ceratopsia, or horned dinosaurs, are fascinating and rather spectacular creatures which have long deserved a detailed, non-technical, treatment. Dodson's *The Horned Dinosaurs* attempts to fill this niche – with some success.

The book is divided into nine chapters. Chapter One introduces the reader to the Ceratopsia and briefly discusses aspects of their taxonomic history and life habits. The second chapter bravely tackles the details of ceratopsian anatomy. Dodson manages to alleviate the potential tedium inherent in anatomical description by introducing a clever 'plot device'. He tells the story of how he assembled, in his own home, the cast of a *Chasmosaurus* skeleton (mail-ordered from 'Big Boo's Bargain Bone Barn'). Chapters Three to Six provide an extended discussion of the discovery, anatomy and taxonomic history of the two major Late Cretaceous ceratopsian groups (i.e. the long-frilled chasmosaurines and short-frilled centrosaurines). Breakthroughs are shown to occur, not only when new material is found, but also when new techniques (such as morphometric analysis) are applied. Chapter Seven provides a similar treatment for the smaller protoceratopsids and *Psittacosaurus*. The eighth chapter deals with our past and current understanding of ceratopsian phylogeny. Dodson provides an outline of cladistic methods and compares the results with those obtained from phenetic analyses. The closing chapter concentrates on the ecology of horned dinosaurs focusing on their feeding mechanisms, stance and locomotor abilities.

The Horned Dinosaurs is written in a lively entertaining style. I particularly enjoyed Dodson's 'thumb nail' sketches of past and present figures in dinosaur palaeontology, and also his ironic and fascinating anecdotes and asides. For example, Dodson describes the exploits of John Bell Hatcher, a 'field man' and later a ceratopsian expert, who collected fossil material for O. C. Marsh during the latter part of the last century. Hatcher discovered that ants collected small objects and incorporated them in their nests – he used this as a handy way to locate rare Cretaceous mammal fossils. Another Hatcher story concerns his poker skills, which he apparently used to keep a Patagonian field trip solvent (and I thought we had funding problems now!).

The book is written in a very clear style which makes it accessible to the non-specialist reader. Dodson deserves credit for not avoiding difficult areas such as cladistic analysis and taxonomic controversy, which he explains simply but without condescension. Anyone who views dinosaur palaeontology as a subject dominated by untestable 'hand-waving' arguments, would perhaps revise their view after reading *The Horned Dinosaurs*: Dodson is keen to emphasize the value of quantitative measurements and the application of statistical techniques. The book is perhaps a little disappointing from the viewpoint of the dinosaur specialist. While Dodson provides a wealth of information on the history and taxonomy of ceratopsians, the abbreviated nature of the description and discussion of anatomical characters limits the value of the book as a technical work of reference – but the author may never have had such a role in mind. Nevertheless, most of the important papers on ceratopsian anatomy and phylogeny are cited, which makes *The Horned Dinosaurs* a good starting point for anyone embarking on original research. It is slightly surprising that the subject of ceratopsian palaeoecology is covered so briefly. For example, although feeding and locomotion are examined, there surely issues relating to social behaviour, parental care, herd structure and so on, which could have been discussed at greater length. The bias towards history and taxonomy, at the expense of palaeoecology, is curious given the probable target audience for this book.

Dodson has succeeded in combining scholarship, clarity and humour, to produce a thoroughly entertaining read. Most important of all, his genuine enthusiasm and fascination for horned dinosaurs is self-evident.

Paul Upchurch