

BOOK REVIEWS

YOUNG, D. A. 2003. *Mind over Magma. The Story of Igneous Petrology*. xxii + 686 pp. Princeton, Oxford: Princeton University Press. Price £46.95 (hard covers). ISBN 0 691 10279 1.
DOI: 10.1017/S0016756803218781

I eagerly anticipated this book after reading Davis Young's gripping biography of Bowen (Mineralogical Society of America, 1998); the prospect of more of his vivid descriptions of events, ideas and interactions between petrologists was mouthwatering. Despite the trickier task posed by surveying the history of igneous petrology over 300 years without having a charismatic hero as the focus of the book, Young has triumphed again, with a quite different style of presentation. Whereas with 'Bowen' it was a breathtaking, compulsive, read-it-in-one account, *Mind over Magma* has to be savoured several chapters at a time, with some days of assimilation and reflection before moving on.

Of necessity, Young does not attempt to be comprehensive, especially as regards the last 50 years. He emphasizes his very limited cover of the literature in Russian, Chinese, Japanese, and Scandinavian languages and the opportunities for historical research there. The topic of volcanology is not included.

The content is chronological, with groups of 3–6 chapters assigned to six 'eras'. For example, the 'Primitive Era' tackles c. 1830–1860 and includes chapters on the origin of granite, rock classification, and early theories of rock diversity; the 'Microscope Era,' c. 1850–1900, includes chapters on the rise of microscopic petrography, igneous rocks in time and space, and early experimental petrology; while the 'Fluid Dynamic Era' (covering the last 25 years) deals with the fluid dynamics of magma chambers and the cumulate controversy. Most readers will have a good knowledge of this final era and many will also be familiar with aspects of the opening 'Foundational Era' (100 BC–1830) in which the Neptunist–Plutonist–Vulcanist dispute and its resolution are reprised. Far fewer will know much about the intervening 140 years, such as the pre-Carnegie Institution history of experimental petrology, or the nineteenth century development of rock classification schemes, or the 1940s granite controversy.

In the final chapter Young makes a convincing case for igneous petrology to become a new theme, separate from geology, in the history of science. To kick-start the suggestion he identifies individuals in need of a biographer, academic institutions and government agencies whose history is inadequately documented, and 'big' ideas that need analysis (e.g. the role of geological surveys in developing the science). He even exhorts today's petrologists to preserve their papers, letters, e-mails and notebooks reflecting on their careers so that future historians of igneous petrology can assess the development of the science through the minds of those currently shaping it.

The book is hardbacked and produced to a very high standard of editing. There are black-and-white photographs of 16 of the c. 450 scientists featured in the text. I regret that more faces are not in the gallery and that the quality of the images is variable. Diagrams and tables are scarce and arguably not all are essential, e.g. the IUGS QAPF diagram.

Should igneous petrologists buy the book? Very definitely, even if you possess a copy of Haraldur Sigurdsson's splendid *Melting the Earth: The History of Ideas on Volcanic Eruptions* (OUP, 1999); the modest price leaves no excuse not to. Should your library have a copy? Again, definitely. Will students read it? Undergraduates and postgraduates will certainly employ the final chapters (1975 onwards) as a literature source and will appreciate the recent explosion of techniques and ideas in the science. However, I suspect few of this group will be tempted to spend time on the earlier chapters. It is mid- and advanced-career petrologists who will read these, keen to discover their roots and details of their large scientific legacy; keen also to reflect on where and how their lifetime's work fits in the grand enterprise of exploration, experiment, thinking and argument that constitutes igneous petrology.

Colin Donaldson

FRASER, A. J. & GAWTHORPE, R. L. 2003. *An Atlas of Carboniferous Basin Evolution in Northern England*. Geological Society Memoir no. 28. vi + 79 pp. (large format, 42 × 30 cm). London, Bath: Geological Society of London. Price £55.00 (paperback, spiral bound). ISBN 1 86239 135 1.
DOI: 10.1017/S0016756803228788

The Geological Society's memoirs have provided a useful and adaptable vehicle for a range of important works, most of style or content not easily accommodated by other academic serials. Some memoirs have been map-rich large-format volumes such as the two on UK oil and gas fields (14 and 20) and the palaeogeographical atlas (13). Others have essentially been commentaries on large fold-out maps, such as Leonard Wills' palaeogeological map volumes (7 and 8) and the compilation of Caledonian orogenic activity (9). There have been single-author volumes on regional geology such as the recent ones on Svalbard (17), and the Highlands (24 and 26). The series has even included two works on the history of geology, on Coles Phillips (23) and Lake District geology (24).

The most recent volume in the series falls firmly into the first of these four categories, although the large A3 format is needed as much to accommodate fold-out seismic sections as full-page maps. Indeed the seismic sections themselves provide the *raison d'être* for the book. They are compiled from BP's formerly extensive collection of onshore seismic data from the UK, said by the authors to be fragmented following 1990s decisions for the company to withdraw from exploration in northern England. The memoir is therefore an attempt to preserve the highlights of these seismic profiles in the public domain and to blend them with data from wells and outcrop observations into a synthesis of Carboniferous basin evolution. The geographical limits are the Southern Uplands to the north and the Wales–London–Brabant Massif to the south, extending west into the Irish Sea and east into the western North Sea.

Chapters introducing the volume and outlining the regional structural framework precede the centrepiece chapter that presents and interprets the seismic sections. Inevitably,

this chapter focuses on those basins regarded as promising economic targets: Bowland and Rossendale; Edale, Widmerpool and Gainsborough; Cleveland and Stainmore. More northern and western basins – Lancaster, Solway and Northumberland – receive more scant attention. However, the whole region is included in a valuable series of palaeogeographic maps in Chapter 4, and an instructive assessment of hydrocarbon play potential in Chapter 5.

The northern England Carboniferous basins have always been fertile ground for academic and well as applied research. This volume provides an accomplished and comprehensive summary of the basins after a significant and, history may show, unique phase of their exploration. It deserves to be a springboard for future research. Perhaps more importantly the memoir provides an excellent teaching resource as an example of an industry-style analysis of potentially productive basins. The Carboniferous basins may be less productive than their offshore Mesozoic cousins, but for teaching they have the great advantage of being exposed in accessible locations. The price of the volume is modest for the wealth of data it contains and it deserves to be as influential as many of the memoirs it succeeds.

Nigel Woodcock

KENNETT, B. L. N. 2001. *The Seismic Wavefield. Volume I: Introduction and Theoretical Development*. x + 370 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £70.00, US \$100.00 (hard covers), £24.95, US \$36.00 (paperback). ISBN 0 521 80945 2; 0 521 00663 5 (pb).

KENNETT, B. L. N. 2003. *The Seismic Wavefield. Volume II: Interpretation of Seismograms on Regional and Global Scales*. xii + 534 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £80.00, US \$120.00 (hard covers), £34.95, US \$55.00 (paperback). ISBN 0 521 80946 0; 0 521 00665 1 (pb). DOI: 10.1017/S0016756803238784

The Seismic Wavefield by B. L. N. Kennett is a comprehensive, two-volume text which links the theory of wave propagation in elastic and anelastic media with the observation of seismic waves from earthquakes and explosions in the Earth. Most textbooks on seismology concentrate on theory; Kennett not only provides a refreshing approach to the theory of wave propagation and the physical processes within the Earth which control seismic waves, but places heavy emphasis on the seismic observations themselves, especially recent broad-band seismic observation. The two volumes are divided into five sections.

Volume I begins with 'Seismic Waves and the Structure of the Earth' – a general survey of the structure of the Earth, an introduction to seismic waves, sources and phases, and finishes by showing how the source and propagation effects combine to build the observed seismogram. This section gives an ideal introduction to seismology and the motivation for pursuing the more rigorous discussion in the second section of Volume I, 'Seismic Wave Propagation: General', which presents seismic sources and wave propagation in a stratified media in much greater detail. Section two ends with a discussion of various methods for constructing the seismic response of a model and the approximations underlying the various methods.

Volume II relies heavily on local, regional and teleseismic observations to show the development of the seismic

wavefield in the Earth using the theory presented in Volume I. The first section, 'Local and Regional Events', discusses the interaction of the seismic source and the source region structure, the nature of the seismogram at near distance, the development of regional phases with increasing observational distance and how crust and upper mantle structure affect the character of these phases. The section entitled 'Global Wave Propagation' examines the seismic wavefield at teleseismic distance including the effects of the deep mantle, the core–mantle boundary and the core on the seismic waveform. The final section of Volume II, 'The Three-Dimensional Earth', discusses the effects of lateral heterogeneity on the seismic wavefield and the imaging of three-dimensional global Earth structure.

Unlike most available seismological texts, *The Seismic Wavefield* offers an excellent blend of theory and observations. It provides a theoretical basis for seismic wave propagation and links the theory to seismic observations. The text discusses various analytical tools used for numerical simulation of seismograms and provides examples of the application of these tools for extracting information about the nature of seismic sources and the structure of the Earth from seismograms. Kennett's text is extremely valuable for graduate-level instruction.

Keith Priestley

CONDIE, K. C. 2001. *Mantle Plumes and Their Record in Earth History*. xiii + 306 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £75.00, US \$110.00 (hard covers), £27.95, US \$39.95 (paperback). ISBN 0 521 80604 6; 0 521 01472 7 (pb). DOI: 10.1017/S0016756803248780

Kent Condie has previously given us a valued text on the role of plate tectonics in the geological record. He extends this effort here with a new text specifically dedicated to a description of mantle plumes, their causes, and their effects on surface geology. Subduction zones and mid-ocean ridge systems might be viewed as the two principal structural components of plate tectonics. These systems are now well understood, perhaps even taken for granted. If we look beneath the lithosphere, we might say similarly that subducted slabs and mantle plumes are the two principal structural components of the mantle convection system – outside of the thermal boundary layers anyway. One could argue that, in dynamical and thermal terms, plumes and subducted slabs are equally important features in the convecting mantle. Subducted slabs have got a lot more attention, however, because they have been evident since the first global maps of mantle seismicity were obtained. Since then, global seismic tomography solutions have shown us that the slabs are even more complex and interesting than we thought. On the other side of the mantle convection system, however, we see that although there is a general recognition that mantle plumes constitute an important form of upwelling in the mantle, their impact on the Earth's surface seems more variable and harder to classify. Condie's book draws together many diverse strands of evidence, however, to provide us with a coherent and very readable picture of the whole topic.

Mantle plumes are more difficult to detect than subducted slabs. Unlike most slabs, they are not delineated by seismicity, and they have presented a greater technical challenge to the resolving power of global seismic tomography maps than have the subducted slabs. Thus, much of what we know about mantle plumes follows from two lines of evidence:

theoretical, computational and laboratory investigations of what mantle plumes should look like, and inferences from geological and geochemical analysis of the effusive products of volcanism attributed to mantle-plume activity. In this text Condie does a good job of presenting and assessing all of the evidence relating to mantle plumes, with extensive citing of the original literature. Whereas other texts include mantle plumes as part of a description of the larger Earth system, this text is focused almost exclusively on mantle plumes, with particular emphasis on the extensive geological evidence that is available. The author makes a valuable contribution to studies of global tectonics in assembling this geologically orientated synthesis. The quantitative side of plume dynamics perhaps gets short-changed in this treatment (there are no equations, some readers will be pleased to see), but I liked the combination of qualitative description and geological evidence. The determined student who wants to extend our understanding of mantle plumes using mathematical modelling can get the necessary equations elsewhere.

The text is presented in nine chapters, with an extensive reference list in the appendix. The first chapter defines the context, with a summary of internal mantle structure and plume nomenclature. Chapter 2 summarizes basic concepts and data pertaining to hotspots and considers the ways in which mantle plumes may interact with the overall convective flow, and with the moving lithosphere. Wide-ranging discussion in this chapter includes sections on hotspot reference frames, plume–ridge interactions, mantle superswells, and plumes on Venus, as well as conceptual explanations of why mantle plumes are associated with geoid and seismic velocity anomalies. Chapter 3 focuses on LIPs (large igneous provinces), and their relationship to mantle plumes, touching on dyke swarms, layered igneous provinces and kimberlites. Most of the major terrestrial examples are described in some detail, with examples from Venus and Mars thrown in for good measure. This chapter provides an exciting overview of the major geological consequences of mantle plumes. These events were pretty much in the global catastrophe class, and their descriptions make the topic more immediate in a way that descriptions of numerical simulations and tank experiments don't quite achieve.

Mantle plumes have, of course, two major manifestations, which the physicist would recognize respectively as the transient plume and the steady-state plume. For the geologist, these two plume types are identified respectively with the large igneous province, and the hotspot trail. The terms 'plume head' and 'plume tail' make the same distinction, rather less clearly. It is perhaps one of the failings of the literature on plumes that the word 'plume' applies to both, and is often used indiscriminately to apply to either. Chapter 4 describes a selection of modelling attempts that mostly represent research efforts from the last decade, that have provided insight into the internal dynamics and structure of plumes, particularly in regard to the formation and development of plume heads. As the author notes, there is a lot more that could be done with this type of model. As the computers keep getting faster, I'm sure that a greater range of complex and detailed plume models will emerge.

Geochemical and isotopic tracers have also been used to try and understand plumes and the source regions from which they originate, and the use of tracers is the focus of Chapter 5, culminating in a brief discussion of the long-standing question of how separate geochemical reservoirs could be maintained in a vigorously convecting mantle. The discussion reminds me that this debate still depends more on cartoons than on quantitative tests, and appears about as

close to being decided as it was 25 years ago when I started in mantle convection. The remaining four chapters deal successively with questions of: (6) how mantle plumes have contributed to the growth of the continents over geological time (both by accretion of oceanic volcanic plateaus to continents at subduction zones, and by underplating), a discussion that depends mainly on geochemical identification of components; (7) mantle plumes in the Archaean, and why komatiites were more common then: 'Heads it's basalts, Tails it's komatiites'; (8) superplumes, what they are, how they might form, impact on the continents; and finally (9) consequences for atmosphere, biosphere and sedimentary systems, under the heading of Earth Systems. The latter section took me to some unfamiliar fields, but offered some intriguing ideas.

The chapter on superplumes is probably the most speculative material in the book. The term superplume is I think not even well defined, though Condie appears to prefer the idea that the superplume is just one enormous (up to 3000 km in diameter) plume. In my view the mechanism that could form such a large plume is yet to be convincingly demonstrated. It seems far more likely to me that a superplume (and I think the concept is rather better documented in terms of its surface effects) is much more likely to consist of a cluster of closely spaced smaller plumes. Again the question of the transient versus the steady-state process may be significant. Cue the modellers.

This year mantle plumes are 40 years old, thanks to J. Tuzo Wilson in a 1963 paper, and coincidentally there are precisely 40 hotspots shown on the map in Chapter 5. This book is also timely, however, because recent presentations at international conferences suggest that the technical problems with accurately mapping mantle plumes by using global seismic tomography are now solved. I expect that when such maps are eventually published, there will be further explosion of interest in, and developments in understanding of, mantle plume systems and their impact on the geological record. Anyway, *Mantle Plumes* is an interesting book to read and it is pitched at a level that should stimulate the interest of the student (undergraduate or postgraduate) who wants to explore outside the standard curriculum of a geology programme, as much as the researcher who delves into these topics in more detail.

G. A. Houseman

ABEGG, F. E., HARRIS, P. M. & LOOPE, D. B. (eds) 2002. *Modern and Ancient Carbonate Eolianites: Sedimentology, Sequence Stratigraphy, and Diagenesis*. SEPM Special Publication no. 71. v + 207 pp. Tulsa: SEPM (Society for Sedimentary Geology). Price US \$125.00 (hard covers); SEPM members' price US \$90.00. ISBN 1 56576 079 4. DOI: 10.1017/S0016756803258787

Deserts are not the windiest places on Earth despite the emphasis in many sedimentology textbooks. Coasts are far windier than deserts. Our appreciation of aeolian depositional processes and products in carbonate systems has been, with some notable exceptions, poor until now. This book addresses that shortfall.

The volume is another in the invaluable SEPM 'red book' series, with half the papers having been originally presented at an SEPM–AAPG oral session at Salt Lake City in 1998. The editors define a carbonate aeolianite as an aeolian

deposit in which carbonates constitute greater than 50% of all grains, and have compiled a set of twelve papers covering a wide range of related topics divided into three sections.

The first section contains two 'overview' papers. The first, by Loope & Abegg, is a short review on recognition and preservation. As someone actively involved in development work on a Cretaceous carbonate gas reservoir with an aeolian component, I found the coverage a little uneven. I suspect what might be termed wet surface deposits are likely to be more common in the stratigraphic record than large dune-form deposits, striking though they are in Quaternary successions. The second paper, on depositional models and diagenesis, is by the editors of the volume and provides a most useful discussion of stratigraphic aspects. It focuses on tropical, warm water systems and complements Brooke's review (*Earth Science Reviews*, 2001, **55**, 135–64) that emphasizes mainly highstand, mainly heterozoan products in dominantly temperate (cool water) and subtropical carbonate provinces.

The second section contains six papers covering Quaternary deposits, several from classical carbonate areas. Carew & Mylroie provide a short review of Quaternary aeolianites of the Bahamas. Curran & White discuss the ichnology of Holocene Bahamian aeolianites. Loucks & Ward provide a description of the stratification styles in aeolianites from the Cancun carbonates of Mexico. Williams & Walkden discuss the dunes of the southern Arabian Gulf. This paper contrasts with others in the volume in discussing an arid, ramp setting. Blay & Longman document Hawaiian examples. The final paper in this group is by Fryberger, Walker & Rutherford on the Youngusband carbonate barrier system of South Australia; I am reminded every time I look at a large, framed aerial photograph of this region at home how geologically deserving of study this region is, so this paper is most welcome. The majority of these papers focus on relatively large dune structures, but I remain to be convinced that such deposits have any real preservation potential outside of ice-house intervals.

The third section is devoted to Palaeozoic and Mesozoic examples. Kindler & Davaud document Lower Cretaceous aeolianites from southeastern France, emphasizing petrographic criteria. The last three papers discuss Mississippian examples from the Illinois, Kentucky and Indiana region. This is comforting in a way because the rapid sea level oscillations of the later Mississippian should have provided ideal conditions for the development of aeolianites, especially in ramp settings, where relatively rapid (forced) regressions caused by ice sheet growth would have created extensive exposures of sediment-providing sources, especially under more arid climates. During subsequent rapid sea-level rises due to ice melt-out, the preservation of aeolian sheets may have been favoured. Dodd, Hunter & Merkley provide a regional study of material from southern Indiana and northern Kentucky. Smith, Al-Tawil & Read focus on similar materials from the Appalachian and Illinois Basin. Abegg & Robertson Handford document examples from southwestern Kansas. The likelihood that significant, high frequency climatic changes took place during the glacial lowstands represented by these aeolian units was not discussed by the authors, even though the evidence for such events from other areas is convincing.

This book is an essential purchase for any university or research institute or company where sedimentary rocks are studied. It deserves to stimulate others to look much more closely at carbonate grainstones. I have already

planned to revisit sections from my thesis area to investigate the possibility of missed aeolian deposits. For individual purchasers the high cost, even for 30-year-long members of SEPM like this reviewer, is prohibitive. For better or worse we live in an increasingly image-oriented world and I feel the book lacks a set of clear, well labelled models to aid the reader in understanding the variability of and influences on carbonate aeolian deposition. That aside, this volume fills a glaring gap in the literature and the editors are to be complimented on their achievement.

Paul Wright

MORTIMORE, R. N., WOOD, C. J. & GALLOIS, R. W. 2001. *British Upper Cretaceous Stratigraphy*. Geological Conservation Review Series, Volume 23. xx + 558 pp. Peterborough: Joint Nature Conservation Committee; purchasing address: NHBS, 2–3 Wills Road, Totnes, Devon TQ9 5XN, UK (www.nhbs.com). Price £53.00 (hard covers). ISBN 1 86107 488 3. DOI: 10.1017/S0016756803268783

This weighty volume describes the 37 GCR sites which expose Upper Cretaceous rocks. The book contains a vast amount of information, including photos and figures reproduced from papers, but is marred by numerous errors and basic omissions of which a selection are mentioned here. The reader may be helped by a brief summary of what has happened to English Chalk stratigraphy in recent years, in particular the proliferation of lithostratigraphic schemes during the 1980s. Naturally, these regional schemes conflicted and competed, with a Lilliput–Broddingnag conflict between schemes developed respectively in the North and South Downs. BGS got in on the act when they realised that there was a demand for maps of southern England showing engineers how hard the chalk is, and they cobbled together a composite stratigraphical scheme using names they had coined whilst mapping Dorset, and those created by Mortimore in Sussex. A major criticism of this GCR book is that it applies the BGS scheme uncritically to all the English conservation sites (see comments in Gale & Hancock, 1999).

After a general introduction, there follows a 54-page account of the biostratigraphy of the English Chalk which includes a number of spectacular fossil misidentifications. For example, the illustration labelled as the Turonian ammonite "*Mammites nodosoides*" is actually the type specimen of *Cunningtoniceras cunningtoni* (Sharpe) from the Middle Cenomanian! The microfossil section does not even mention nannofossils, which are the most widely used zonal taxa for Cretaceous chalks globally. Indeed, there is no mention, anywhere in the book, that a nannofossil zonation even exists for the English Chalk, which is amazing considering what chalk is composed of (but see Burnett, 1998)!

There is little consistency as each GCR site is described in variable detail, with or without photographs. The detailed logs are virtually incomprehensible because they are reproduced at too small a scale, and are too roughly drawn to be usable in the field or anywhere else. The symbols are entirely unexplained and baffling, and the background shading is used quite inconsistently to depict all sorts of things.

There is a highly selective approach to referencing throughout which is both misleading and unscientific. For example, a paper published in 1998 in *Earth and Planetary Science Letters* on the magnetostratigraphy of the English Chalk based largely at Whitecliff on the Isle of Wight

(Montgomery *et al.* 1998) is not even cited in the extensive description of this locality. Instead, these discoveries are credited solely to an obscure French doctoral thesis.

In summary, this book appears to be more concerned with consolidating and publicizing the stratigraphical scheme devised by the authors and BGS than it is of providing an objective assessment of individual sites. The book gives the very narrow impression that stratigraphy is entirely about nomenclature and correlation, and that palaeontologists merely list biostratigraphically useful fossils. There is virtually nothing on how individual sites may contribute to our understanding of palaeoenvironmental change, ancient climates and sea-levels or even the geological history of the UK.

One final point which applies to the whole series. There is no comment on the actual value of sites today, and the absence of key localities from the GCR list. Some conserved localities have little research value, whilst other unlisted localities are very important. For example, the section west of Eastbourne, which is currently of great international interest as a Cenomanian–Turonian locality, bizarrely remains without protected status and was recently severely damaged by sea-defence works.

A. S. Gale

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- BRYANT, E. 2001. *Tsunami: The Underrated Hazard*. xxx + 320 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £55.00, US \$74.95 (hard covers), £19.95, US \$27.95 (paperback). ISBN 0 521 77244 3; 0 521 77599 X (pb).
DOI: 10.1017/S001675680327878X

A couple of decades ago, the only experience or knowledge most people in the West had of tsunami was based on Hokusai’s famous early 19th Century woodcut. Here a giant wave towers above a distant Mount Fuji and some boats in the foreground. However, as Edward Bryant explains in *Tsunami: The Underrated Hazard*, Hokusai’s wave form has been misconstrued because it is in fact a wind-generated N-wave, characterized by a very deep leading trough and asymmetrically peaked crest. Only when close to shore do tsunami sometimes assume such shapes. Nevertheless, Hokusai’s iconic wave image is still one of the most dynamic illustrations of the potency of a tsunami. There are still no good photos. They may have been taken but the photographers have not survived. However, Bryant’s carefully researched book is full of pictures of the aftermath of tsunami waves which are evidence enough for the phenomenon to be treated seriously as a significant hazard to coastal communities around the world. Even the British Isles are not immune if the coastal evidence of tsunami impact from the Storegga slides is to be believed.

Edward Bryant is an associate professor and head of Geosciences at the University of Wollongong, New South

Wales, Australia and a serious tsunamiphile who has tracked the big waves around the world and into the geological past. *Tsunami: The Underrated Hazard* presents a very wide-ranging review of the subject from detailed historical evidence with all the facts and figures through Bryant’s analysis of tsunami-formed landscapes to causes and assessments of modern risks. As such, *Tsunami* represents a very useful introduction and review for students, with plenty of ooh-aah factor to generate interest in the topic and a good dose of data, plus selected references to original publications and websites.

The most controversial section is that dealing with postulated tsunami-generated coastal forms, especially scoured bedrock surfaces. As a general reader interested in the topic, this was one area where I felt a need to hear the other side of the story. Bryant may be proved right in his analysis but I think that student readers might need to be particularly cautious and critical here. I see that the book is dedicated to J. Harlen Bretz who battled for 50 years to get his interpretation of the flood-generated channelled scablands accepted. Perhaps Edward Bryant identifies with Bretz’s struggle to get new ideas taken seriously. The late Derek Ager would certainly have approved of this book and cheered the author on.

Douglas Palmer

- WORDEN, R. H. & MORAD, S. (eds) 2002. *Clay Mineral Cements in Sandstones*. International Association of Sedimentologists Special Publication no. 34. viii + 509 pp. Oxford: Blackwell Science. Price £75.00 (paperback). ISBN 1 40510 587 9.
DOI: 10.1017/S0016756803288786

The 34th special publication of the International Association of Sedimentologists contains 21 papers which are divided into five sections: review papers (12), chlorite case study (1), kaolinite case studies (4), illite case studies (3) and glauconite case study (1). They are a disparate group of papers of particular interest to earth scientists who are concerned with the general setting of clay minerals within sediments and the role played by authigenic clay minerals within hydrocarbon reservoirs. Worden & Morad set the overall scene in their review of the controls on the formation, distribution and evolution of clay minerals in sandstones. This is followed by reviews on the predicted distribution of diagenetic clay minerals in a sequence stratigraphic framework (Ketzler *et al.*), controls on the oxygen and hydrogen isotopic composition of diagenetic clay minerals (Morad *et al.*), palaeoclimatic controls on spectral gamma-ray radiation from sandstones (Ruffell *et al.*), controls on the occurrence and behaviour of smectite during diagenesis (McKinley *et al.*), patterns of clay mineral diagenesis in the interbedded mudrocks/sandstones of the Palaeocene, North Sea (Shaw & Conybeare), cross-formational flux of Al and K in the Gulf coast sediments of the United States (Wilkinson *et al.*), fluid compositional control and potential for the generation of overpressure in sedimentary silicate–carbonate reactions (Hutcheon & Desrocher), experimental studies of clay mineral occurrences (Manning), effects of clay upon some physical properties of sandstones (Worthington), quantitative analysis of clay and other minerals by X-ray diffraction (Hillier) and dating techniques for clay mineral cements (Hamilton).

The paper by Anjos *et al.* on chlorite development and porosity preservation in the Upper Cretaceous marine

sediments of the Santos Basin (Brazil) is the only chlorite case study. The kaolinite case studies consist of Marfil *et al.* on the kaolin in the Jurassic–Cretaceous reservoir and associated sediments of the Salam Field (Egypt), Milliken on the mass balance implications of kaolin distribution in the Carboniferous Breathitt Formation (US), Ketzer *et al.* on the relationship of the early Cretaceous unconformity to the development of kaolin and reservoir quality in the Triassic sediments of the Snorre Field (North Sea), and Brosse *et al.* on the formation and stability of kaolinite in the Brent Sandstone of the Hild Field (Norway).

The section on illite case studies consists of Lemon & Cubitt on the use of fluorescence microscopy in studying illite in the Palaeozoic Merrimelia Formation (Australia), Sanjuan *et al.* on geochemical modeling of illite and quartz cementation in the Brent sandstone of the Hild Field, North Sea (Norway), and Worden & Barclay on the effect of oil emplacement on the diagenetic clays in the Upper Jurassic Magnus Sandstone, North Sea (UK).

Glauconite is the subject of a paper by Schulz-Rojo *et al.* who describe how variation in the morphology of glauconite (*s.l.*) grains can help in controlling the stratigraphical integrity of horizontal oil development wells. There is a 20-page subject index.

The general quality of the text, figures and plates is good. More vigorous editing would have benefitted the reader, reduced the price and the total number of pages to be read. The volume lacks cohesion; there has been an attempt to turn this disparate group of papers into a coherent whole when it is clearly not so. This also results in parts of the volume not being at the conceptual or practical cutting edge of clay science and its application to sediments. The great range of topics reflects not only the volumetric importance of clay minerals within sediments, but also the extensive role they play in modifying the ideal conditions that are only dreamt about by earth scientists involved in hydrocarbon exploration and field development. The volume is a must for anyone who is seriously thinking of entering this field of activity.

C. V. Jeans

SMELLIE, J. L. & CHAPMAN, M. G. (eds) 2002. *Volcano–Ice Interaction on Earth and Mars*. Geological Society Special Publication no. 202. vii + 431 pp. London, Bath: Geological Society of London. Price £90.00, US \$150.00; members' price £45.00, US \$75.00; AAPG members' price £54.00, US \$90.00 (hard covers). ISBN 1 86239 121 1.
DOI: 10.1017/S0016756803298782

In recent years interest in the interactions between volcanoes and ice has steadily increased amongst scientists studying Earth and Martian processes. Earth scientists working on terrestrial examples of putative subglacial volcanoes have continued to gather outcrop-scale information, often during physically demanding field campaigns in remote parts of Antarctica, Iceland, Canada and Southern Chile, i.e. in volcanically active regions of the Earth which were ice-covered at some time during the Late Cenozoic Ice Age. In contrast, scientists studying Mars have had to rely on remote sensing techniques and interpretation. The tools used for study of these two planets are necessarily different and the eruptive environments contrast in that Mars experiences approximately a quarter of Earth's gravity and a thinner atmosphere. However, similar physical laws of magma–ice interactions can be applied to both planets, and the

surface manifestations of magma–ice interactions are likely to have broad similarities on Earth and Mars. This book represents a pioneering attempt to draw together the scientific findings of the volcano–ice interaction communities who have been focussing on each of these planets. I believe this to be a fabulous collection of papers for a number of reasons: (1) there appear to be contributions here from all the key scientists currently working in this field; (2) exciting recent discoveries are documented as well as reviews of established work; (3) all of the papers have been thoroughly reviewed and (4) the editors have skillfully organized the book into themes which has resulted in contributions to each from both the 'terrestrial scientists' and the 'Martian scientists'. The themes are: eruptive, hydrological and glacial dynamics, and tephra chronology of subglacial eruptions; reconstruction of sub-ice volcanoes and ice sheet thicknesses from geomorphological and lithofacies analysis and volatile compositions; remote sensing of terrestrial and Martian subglacial features; hydrothermal evolution, and mineralogical and biological formation of palagonite.

The introduction, written by Smellie & Chapman, succinctly summarizes the contents of each of these sections and I would refer prospective readers to this. I found each paper in the book fascinating and, at times, had difficulty putting the book down. I haven't been able to say that about a textbook for some time. Well done John and Mary!

Jennie Gilbert

MCCAFFREY, W. D., KNELLER, B. C. & PEAKALL, J. (eds) 2001. *Particulate Gravity Currents*. International Association of Sedimentologists Special Publication no. 31. vii + 302 pp. Oxford: Blackwell Science. Price £55.00 (paperback). ISBN 0 632 05921 4.
DOI: 10.1017/S0016756803308787

The last decade has seen a huge research effort focused on gravity current processes and products, in response to hydrocarbon exploration for submarine fan reservoirs in deep-water frontier areas and our need to better predict and mitigate against geological hazards such as debris flows and lahars. This book is a timely collection of recent work on the fundamental processes of particulate gravity currents, and arose from the conference 'Sediment transport and deposition by particulate gravity currents' held in December 1998 at Leeds, UK. Papers deal with a range of natural systems, including siliciclastic turbidity currents and debris flows, pyroclastic density currents and avalanches. The book is organized into four sections, based on different research approaches to particulate gravity currents. This structure successfully highlights the physical processes common to different natural systems, and serves to integrate different theoretical, experimental and observational approaches to their description.

The first section of the book comprises six papers on theoretical and numerical modelling of flows, while the second section consists of four papers combining theoretical and experimental modelling approaches. Many of the papers in these two sections review the mechanics of flow processes and several expand significantly on the original work of Bagnold and others which has underpinned geological models of gravity flow deposits over the last 40 years (e.g. Campbell's study of rheology in flows that exhibit a change from quasi-static to rapid-flow regime and Straub's numerical modelling of high-concentration sediment flows). Much of the theoretical work demonstrates the shortcomings of

standard classifications of flow types (e.g. grain flows, debris flows, turbidity currents) in understanding the process continuum that operates in natural systems. However, only two of these papers contain comparisons with real-world case studies (both Takahashi and Nakagawa *et al.* use data from recent subaerial debris flows to test the results of numerical models), highlighting the need to test our current theoretical understanding against high-quality observational datasets from modern natural systems.

The book's third section comprises four papers on experimental modelling. The papers in this section emphasize the use of new techniques in describing flow structure and depositional patterns (e.g. Best *et al.* and Buckee *et al.* respectively document the use of ultrasonic Doppler velocity profiling and laser Doppler anemometry to describe turbulent flows in unprecedented detail, while De Rooij & Dalziel describe detailed temporal and spatial variations in depositional rates from experimental turbidity currents). The final section of the book comprises five field-based studies of ancient gravity flow deposits. These studies demonstrate that detailed reconstruction of transport and depositional process is possible using careful analysis of field data (e.g. Clark & Stanbrook's study of shear structures at the base of high-density turbidite deposits), and several flows of unusual rheology are documented (e.g. Martin & White and Föhlisch & Voigt describe gravity flows in submarine pyroclastic and partly consolidated carbonate sediments, respectively).

The editors' aims in compiling this book have been to illustrate the broad range of research that has been undertaken on particulate gravity currents, and to stimulate the integration of different research approaches. The book certainly achieves the former, and it will prove useful for both geologists and non-geologists investigating the processes that operate in particulate gravity flows. More specifically it is required reading for those seeking to use numerical and experimental approaches to understanding natural flows, but I would recommend a thorough browse through the book to any field-based researcher working on modern or ancient gravity flow deposits. As the editors state in their introductory paper, an integrated approach has the potential to make significant progress in understanding – and from my perspective as a field-based geologist, many of the numerical models and experimental results presented here are crying out to be tested against high-quality outcrop datasets.

Gary J. Hampson

HOLLAND, C. H. & BASSETT, M. G. 2002. *Telychian Rocks of the British Isles and China (Silurian, Llandovery Series)*. Geological Series no. 21. 210 pp. Cardiff: National Museums & Galleries of Wales. Price £14.99 (paperback). ISBN 0 7200 0455 1.
DOI: 10.1017/S0016756803318783

The House of the Distant View of the Dragon King Temple, on an island in the lake of the Summer Palace of Beijing, must have been a terrific place to plan a scientific programme. Here, in 1984, Chinese and British geologists met to plan details of collaboration of a project, under the auspices of the Royal Society and Academia Sinica. The idea had been proposed by Charles Holland: to take a single, narrow interval of the Early Palaeozoic (the Telychian) and compare the successions and fossils of that age in Britain and China as an exercise in precise stratigraphic correlation, with Chinese and UK stratigraphers working in close collaboration. This volume gives the results of what became

the 'Transhemisphere Telychian' project. Did it succeed? One problem with multi-author volumes of this sort is that they become monsters to organize and complete, and it's obvious that the contributions are of various vintages. Nevertheless, there's a great deal of value here, and it is obvious that this project sparked a lot of mapping and stratigraphic analysis of the Chinese successions in particular.

A preface outlines the history and rationale of the project (more would undoubtedly have been fascinating, given that Chinese science was recovering from the turmoil of the Cultural Revolution), followed by an essay on stratigraphic principles by Charles Holland (excellent, though with little obvious relation to the T-T project). Then, the main part of the volume comprises descriptions of the stratigraphy of the Chinese (the Yangtze Platform, to be specific; still a huge area) and the UK successions. These are a little dry and factual, and one has to turn to the end of the volume for discussion of facies and palaeogeography, and of synthesis in particular of the Chinese data. There are some strange omissions: no global palaeogeographic map, for instance, to show where the various bits of China and the UK are thought to have been in the Telychian.

Then come comparisons of the macro- and micro-fossil groups, co-authored by UK and Chinese workers, the former including the usual suspects for this sort of study. Although the aim of the project was high-resolution biostratigraphy, the exercise turned out rather to offer insights into provinciality. The correlation bit is despatched pretty quickly with the first fossil group, the graptolites: they show a good four-fold biozonation in both areas, which match pretty well, despite there being only 10% or so of the species in common. Graptolites, in fact, seem to be amongst the most provincial of the fossils here, despite their reputation as intrepid Palaeozoic seafarers, though this might also have something to do with the dominantly shallow-water facies of the Yangtze Platform successions. It also shows that, for correlation, speed of evolution is all, and you simply need enough commonality of distinctive fossils. Then, the other groups: conodonts, acritarchs, chitinozoa, corals, brachiopods, cephalopods, bivalves, trilobites. The general pattern is a discussion of taxonomy (with synonymies being efficiently chased down, a necessary start to assessment of levels of endemism), illustrations of characteristic forms, and comparative range charts. Trilobites emerge as the most provincial creatures of all, with only three genera in common: awful for correlation, great for palaeogeography. Bivalves are cast as the Cinderellas, with little information from either region, but more than a hint of useful potential. Brachiopods are classic fossils in the UK Telychian for both correlation in shallow-water facies and palaeodepth analysis. On the Yangtze Platform, they're still useful, though with different lineages (no *Pentameroides*, no *Eocoelia*) and there aren't such nice depth-control patterns. And rugose corals show significantly more endemism than the tabulates: more temperature sensitive, perhaps?

It's a nice piece of work, if rather dated in places (the UK stratigraphic account has little mention of, for instance, David Loydell's revision of Telychian graptolite zones or of the BGS remapping of central Wales – though the 'Facies and Palaeogeography' section draws heavily on the latter; and there's no discussion of, say, how carbon and strontium isotope patterns might complement the palaeontological data). Where can it lead to? This kind of work now tends to be overshadowed by the almost unbelievable palaeontological riches coming out of China, as broadcast in both

learned journals and tabloid newspapers. So where can such painstaking correlation studies fit in? Arguably, tracking the history of total biotas through time is now more vital than it has ever been, as uniformitarianism is stood on its head and geological history is scoured for parallels to the possible behaviour of the greenhouse world of the future. It would be wonderful to view this project as a stepping-stone to tracking transhemispheric patterns of biological and climatic change across this interval. So, snap up this book, a snip at £14.99, and browse through it as you plot how to snare your next grant for research into the evolution of the global palaeoenvironment.

Jan Zalasiewicz

WHITE, J. D. L. & RIGGS, N. R. (eds) 2001. *Volcaniclastic Sedimentation in Lacustrine Settings*. International Association of Sedimentologists Special Publication no. 30. vii + 309 pp. Oxford: Blackwell Science. Price £52.50 (paperback). ISBN 0 632 05847 1. DOI: 10.1017/S001675680332878X

This special publication of the International Association of Sedimentologists brings together 13 papers on various examples of volcaniclastic sedimentation in lacustrine settings. The examples range geographically from Antarctica, through Australia, New Zealand, Germany, Iceland, North America to Kamchatka in Russia, and in age from the very recent (1996) to the Devonian. The 13 papers fall into three general groups: eruptions in lakes and eruption-formed lakes, sedimentation and redistribution of pyroclastic debris in the lacustrine environment, and lake deposits as sensitive recorders of eruption history.

The first group (three papers) consists of a fascinating interpretation of how the Icefall Nunatak volcano developed beneath and within the Antarctic ice sheet after forming its own subsurface lake (J. L. Smellie), a very readable account of the 1996 eruption within the partially frozen Karymskaya intra-caldera lake, Kamchatka, by Belonov & Belonova, and an account by J. D. L. White of the eruption history of the Pahvant Butt volcano in the Pleistocene Lake Bonneville (USA) and its modification by lacustrine processes.

Three of the six papers dealing with the deposition of pyroclastic sediments in lake settings are concerned with various aspects of the debris from the huge ignimbrite eruption (105 km² ≡ 30 km² dense rock equivalent) from the Taupo caldera in New Zealand some 1800 years ago; the sedimentology and history of Lake Reporoa (V. Manville), the character of the marginal sedimentation in Lake Taupo after the great eruption (Riggs *et al.*) and an experimental study on the settling behaviour of pumice from the AD 181 Taupo eruption (White *et al.*). The scene then moves to the United States. Palmer & Shawley describe lacustrine–fluvial transitions within the pyroclastic sediments associated with the Eocene Challis volcanic field in Idaho. The volcanic and hydrothermal influences in the Eocene lake sediments of North Washington are discussed by Gaylord, Price & Suydam. The group of six papers is completed by an account of the influence of magmatism and tectonics on the Upper Devonian Bunga beds of the Boyle Volcanic Complex in SE Australia (Cas *et al.*).

The third group consists of four papers. A detailed study on a sediment core (~6 m) from Lake Hestvatn, southern Iceland, shows how careful investigations with a thorough understanding of the limitations can provide a remarkable insight into the eruptive history of this region (Hardardottir,

Geirsdottir & Thordarson). M. Caballero and his co-workers describe the late Pleistocene–Holocene volcanic sequence of environments in the upper Lerma basin of Mexico. The variations in the well-known kaolin-rich tonsteins in the Carboniferous–Permian of the Saar–Nahe Basin (SW Germany) are related to their different sedimentary settings by Königer & Stollhofen. Reidel, Pringle & Schuster suggest that the very thick pyroclastic deposits associated with a landslide-dammed lake on the upper Skagit River, Washington, were concentrated from the widespread (2 cm thick) ash from the cataclysmic eruption of Mount Mazama at ~6700 years BP. The editors provide a useful introduction section for the 13 papers within the overall context. There is a ten-page index.

The editing is good. I have some quibbles. The high gloss paper is not easy to read from. The price (£52.50) puts the volume beyond many libraries these days, particularly as it is not a multi-user volume such as a textbook might be. Some of the papers are loaded with excessive terminology that could render them practically unreadable – ‘Intralacustrine syn-depositional intrusive autoclastic provenance’ (p. 83) – and that’s in an abstract.

C. V. Jeans

JOLLEY, D. W. & BELL, B. R. (eds) 2002. *The North Atlantic Igneous Province: Stratigraphy, Tectonic, Volcanic and Magmatic Processes*. Geological Society Special Publication no. 197. vi + 337 pp. London, Bath: Geological Society of London. Price £85.00, US \$142.00; members’ price £42.50, US \$71.00; AAPG members’ price £51.00, US \$85.00 (hard covers). ISBN 1 86239 108 4. DOI: 10.1017/S0016756803338786

The North Atlantic Igneous Province: Stratigraphy, Tectonic, Volcanic and Magmatic Processes – with such an impressive title, this volume is likely to immediately grab the attention of anyone working on this vast area. However, on glancing down the list of contents, I was initially a little disappointed to find that half of the papers are centred around the Faroe–Shetland region. Furthermore, there is only one contribution from Eastern Greenland and nothing on the other ‘classic’ areas of the North Atlantic Igneous Province (NAIP) such as Iceland and the NW British Isles but this is perhaps missing the point. What this book does provide is a collection of twelve papers on diverse aspects of some of the often-overlooked areas of the NAIP including several on the submarine expression in the NE Atlantic and, as much of this work has been driven by oil exploration, the papers provide a different perspective on the geology of the region.

Contributions by Jolley & Bell on the opening of the NE Atlantic, Smallwood & White on ridge–plume interaction in the North Atlantic and Eldholm *et al.* on the structure of the Norwegian continental margin provide an excellent overview to set the scene, whilst subsequent sections cover aspects of the Faroe–Shetland Basin, Greenland, the Faroe Islands, and intrusive complexes (sills in the Faroe–Shetland Basin).

The six papers that cover the Faroes region include those by Morton *et al.* who present a provenance study of the Foinaven sub-basin, west of Shetland, and link changes in the heavy mineral source regions to the onset, and tentatively to the waning, of magmatism in the British Tertiary Igneous Province. This is followed by a petrological and biostratigraphical study by Jolley & Bell of

the well-preserved but buried volcanic succession of the Erlend volcano, north of Shetland. Waagstein *et al.* have accomplished reliable dating of the onshore Faroes flood basalts using K–Ar and Ar–Ar methods despite a regional zeolite facies metamorphism whilst Ellis *et al.* present the stratigraphy and palaeoenvironment of both the onshore and offshore volcanics and associated sediments of the Faroe–Shetland Basin. Finally, two papers by Smallwood & Maresh and Bell & Butcher use high resolution seismic data to determine the emplacement, distribution and 3D morphology of sill complexes in the Faroe–Shetland Basin.

Work on Greenland includes that by Nøhr-Hansen *et al.* on the Early Palaeocene biostratigraphy of the onshore lithologies of Western Greenland where they correlate the biostratigraphy with radiometric and palaeomagnetic data to provide an age for the onset of magmatism and associated precursor tectonic events. This is complimented by a high resolution study (< 20 ka) by Pedersen *et al.* of the volcanism and tectonic evolution of the Nuussuaq Basin (also West Greenland) during the C27n–C26r palaeomagnetic polarity transition. In East Greenland, Hansen *et al.* present the volcanic stratigraphy of Prinsen af Wales Bjerge region, and propose two new volcanic formations on the basis of stratigraphic, geochemical and age data.

As expected from the Geological Society publishing house, production standards are excellent and all of the illustrations (including several in colour) are of a very high quality. In summary, this publication will be essential reading to many working on the NAIP and indeed anyone working on the NE Atlantic, especially in the Faroe–Shetland region. My only minor criticism is that the title is slightly misleading as many of the papers will be of interest to the ‘soft rock’ community who may be initially put off by the ‘hard rock’ connotations of the title.

Matt Power

MENZIES, M. A., KLEMPERER, S. A., EBINGER, C. J. & BAKER, J. (eds) 2002. *Volcanic Rifted Margins*. Geological Society of America Special Paper no. 362. vi + 230 pp. Boulder: Geological Society of America. Price US \$80.00; members’ price US \$64.00 (paperback). ISBN 0 8137 2362 0.
DOI: 10.1017/S0016756803348782

This GSA Special Paper provides a timely review and synthesis of the key features associated with rifting and magmatism. It is based on a meeting held in the University of London (Royal Holloway) in Spring 2000 and contains regional perspectives, together with reviews on rock associations and the general characteristics of geological events linked with the rifting of continental areas and the onset of ocean floor spreading. Related themes of tectonism, uplift history and erosion are also dealt with and provide the reader with an excellent platform for further reading. The range of data reviewed by the various authors is impressive: from global and regional geophysical datasets, through field observations (both structural and lithological), to geochemical information. It would appear that virtually no stone has been left unturned! The figures are of a uniformly high standard and include some excellent examples in colour.

Menzies *et al.* set the scene with a useful summary of the key features of volcanic rifted margins. A helpful composite section through a volcanic rifted margin and a tabulation of characteristics permit the non-specialist to understand

the important similarities and differences between the main provinces.

We are then treated to a global tour of the most important rifted margins in which magmatism has played a key role. The coverage is not uniform or complete; for example, reviews of the North Atlantic Igneous Province (NAIP) and the Central Atlantic Magmatic Province (CAMP) would have been useful, although key references are thoughtfully provided by Menzies *et al.*

Within the Atlantic Basin, contributions on the East Greenland coast-parallel dyke swarm and the evolution of the South Atlantic margins are presented by Klausen & Larsen and Mohriak *et al.*, respectively. Two papers (Corner *et al.* and Trumbull *et al.*) explore the use of geophysical data towards understanding the nature and development of the Namibian volcanic margin. Other reviews of rifts within and around the African continent include: East Africa (Nyblade), Lebombo (Watkeys), the Afar (Baker *et al.*) and NE Madagascar (Melluso *et al.*). The only contribution on a North American rift system is provided by Miggins *et al.* and takes the form of a detailed geochronological analysis of extension and uplift associated with the Rio Grande Rift.

Two excellent reviews of the rock associations within volcanic rifted margins are a welcome feature of the publication. Jerram reviews the volcanology and facies architecture of the spectacular basaltic lava fields which develop on rifted margins, whereas Bryan *et al.* tackle the less well studied silicic volcanic rocks. These assessments of the state of knowledge of rocks at both ends of the compositional spectrum will be of particular use to researchers working in provinces where basic fieldwork is yet to be completed.

In summary, this volume is an excellent addition to the literature and will be of use both to researchers in the field, as well as to undergraduate students who wish to gain a clear understanding of this important igneous–tectonic association.

Brian Bell

MENZIES, J. (ed.) 2002. *Modern & Past Glacial Environments*. Revised student edition. xxi + 543 pp. Oxford, Auckland, Boston, Johannesburg, Melbourne, New Delhi: Butterworth-Heinemann. Price £47.50 (paperback). ISBN 0 750 64226 2.
DOI: 10.1017/S0016756803358789

Modern & Past Glacial Environments represents the combination and revision of *Past Glacial Environments* and *Modern Glacial Environments*, also edited by John Menzies in the mid 1990s. In so doing, some material has been lost and other material has been updated. The outcome is a text that still runs to well over 500 pages and which contains a broad spectrum of material and approaches.

The framework for the 16-chapter volume is presented in the initial two chapters, entitled ‘Glacial Environments – Modern and Past’ and ‘Global Glacial Chronologies and Causes of Glaciation’. The latter provides a useful summary of glacial activity throughout the Earth’s history. Chapter 3, ‘Glaciers and Ice Sheets’, considers the basic physical processes governing ice mass behaviour. Chapter 4, ‘Ice Flow and Hydrology’, covers a large amount of material. Upon close inspection, some of this might have been presented more clearly. For example, on page 107 the claim is made that ‘The amount and form of supraglacial meltwater activity would seem to be little influenced by the thermal state of the underlying ice mass. It might be expected that the volume of

meltwater on a cold (polar) glacier might be less. However, little evidence exists to support this impression.' Elsewhere, not all topics have been fully updated. For example, there is no mention of recent work by Murray and colleagues on Svalbard glaciers in the discussion of surge-type (termed 'surging') behaviour. In contrast, Chapter 5 on 'Processes of Glacier Erosion' is succinct (15 pages) and precise. This chapter provides a useful starting point for those who wish to adopt a quantitative approach to understanding or modelling processes of glacier erosion. Chapter 6 considers 'Processes of Glacial Transportation', and is generally well presented, although some statements that may confuse students do slip through (e.g. on page 149: 'The pressure exerted by even the largest boulders resting on glacier surfaces rarely exceeds the yield stress of ice, so that glaciers transport material of about three times the density of ice without the debris sinking').

The seventh chapter, 'Processes of Terrestrial Glacial Deposition', presents a brief (11 pages) overview of different processes of deposition and the nature of the resulting sediments. In stark contrast, Chapter 8, 'Subglacial Environments', is 96 pages long and provides an informative review of a broad range of approaches to studying and characterizing the basal zone of ice masses. Chapter 9, 'Sediments and Landforms of Modern Terrestrial Environments', is similarly authoritative, focusing heavily on processes moulding the proglacial landscape. Consequently, some fairly active research areas, such as the study of proglacial suspended sediment dynamics, are under-represented in the chapter while, for example, jökulhlaup-related deposits are given a full airing. The relatively short Chapter 10 considers 'Supraglacial and Ice-marginal Deposits and Landforms'. Chapters 11 to 13, respectively entitled 'Glaciolacustrine Environments', 'Modern Glaciomarine Environments', and 'Past Glaciomarine Environments', are well presented and authoritative, providing useful information in these fields that are not always covered adequately in other texts. Chapter 14 is concerned with 'Processes of Glaciotectonism', and provides an excellent review of the relationships between stress fields and structure in glacial sediments at a variety of scales. The penultimate chapter (Chapter 15) considers 'Glacial Stratigraphy', summarizing, with reference to examples, the basis of stratigraphy and the physical properties concerned. Despite cutting across the structure of other chapters, this chapter works well, building on the process-form relationships that emerge earlier in the text. In Chapter 16, 'Problems and Perspectives', the editor highlights a useful series of issues demanding continued investigation, classified according to the text's principal environments.

In summary, this student edition is broad and informative. On the whole, the text is well-produced, clearly written and fully illustrated. Its constituent chapters are, however, of variable approach, length and quality. On the downside, I found some of the text confusing, some illustrations to be of poor quality, and at least one illustration was duplicated. Many chapters have also not been adequately revised to include all relevant recent developments. For example, modern numerical models are not summarized in Chapter 3, super-cooling is not discussed in Chapter 4, the analysis of grain-fracturing and self-similarity in deformed subglacial sediments is omitted from Chapter 6, and structural glaciological controls over supraglacial debris features (and their proglacial expression once deposited) are omitted from Chapter 10. At almost £50 for the paperback edition, the volume is also expensive. On the other hand, some chapters (e.g. 5, 8, 12, 13 and 14) do provide genuinely noteworthy additions to the literature.

The volume should form an essential part of any library of glaciological texts, and should certainly be available to all interested undergraduates and researchers, particularly those following the glacial geomorphology side of the discipline. However, its shortcomings do not place it in a strong position in the face of cheaper and, in many cases, more up-to-date undergraduate texts such as Benn & Evans' excellent *Glaciers and Glaciation*.

Bryn Hubbard

Reference

BENN, D. I. & EVANS, D. J. A. 1998. *Glaciers and Glaciation*. Edward Arnold, 760 pp.

OLDROYD, D. R. 2002. *Earth, Water, Ice and Fire: Two Hundred Years of Geological Research in the English Lake District*. Geological Society Memoir no. 25. xvi + 328 pp. London, Bath: Geological Society of London. Price £85.00, US \$142.00; GSL member price £42.50, US \$71.00; AAPG/SEPM/GSA member price £51.00, US \$85.00; hard covers. ISBN 1 86239 107 6. DOI: 10.1017/S0016756803368785

Professor Oldroyd writes extremely well and manages to make entertaining and informative what could have been a huge chunk of indigestible geological parochialism. His book is the scientific biography of a picturesque region of England. Its varied geology and the range of physical processes that have operated on its rocks are in large measure responsible for its allure and the author is thus faced with drawing together disparate scientific strands woven by a cast of hundreds, many of whom are alive and still active in Lakeland geological research. He makes no apologies for his book being a labour of love and the labour involved is certainly impressive. The first part is fairly traditional history of science fare based on extensive archive and literature research but, as we move forward towards the present, interviews and correspondence with a cosmopolitan array of geologists give the book a rather more personal feel. This could be a slightly biased viewpoint, however, since I find myself one of the interviewed and quoted sources. Hopefully my 'walk-on' role has not coloured this review too much.

There is a much-quoted aphorism that claims 'Geologists are extremely good company – for other geologists'. After reading this book you may well begin to wonder since it is the Oldroyd style to seek out conflicts and controversies. So, in the very first chapter we are left with the suggestion that the Father of British Geology, William Smith, slighted the Father of Lakeland Geology, Thomas Ottley, the 'local boy made good'. It was pleasing to see Ottley getting the credit he deserved though. Chapter 2 takes us into familiar Oldroyd territory with Sedgwick strengthening his position in his long-running battle with Murchison. There is no doubting where the author's sympathies lie: Sedgwick's 'heroic endeavour' contrasts with Murchison's 'Silurian empire-building'. The Sedgwickian succession is then represented in Chapter 3 by Harkness and Nicholson, Lapworth it seems being uncharacteristically reticent in Lakeland matters. Perhaps though, the most important lead in Chapter 3 is Professor Oldroyd's introduction of the concept of 'amateurs' (most of whom were actually academic professionals) versus 'surveyors'. Is this simply Sedgwick versus Murchison in a different guise? It is certainly a potent influence in the book's later chapters.

The first surveyors get Chapter 4 pretty much to themselves, though the emphasis on conflict continues with

just about everyone being rotten to poor Aveline, and Ward being abandoned to solitary mapping on the high fells. Chapter 5 returns to Cambridge with Marr taking on Sedgwick's mantle and systematic palaeontology proving its worth; Harker attracts a bit of disapproval, with the suggestion that he sold out to Murchison in return for a job. Chapter 6 introduces a plethora of characters working on the structure and volcanic rocks, and from here on the geologists come thick and fast. To pick out a personal choice, I discovered much about J. F. N. Green's work that I had not previously appreciated, not least his innovative application of truncated cross-bedding to establish sedimentary 'way-up'—this in 1924.

By the time we reach Chapter 7 we are into the book's modern era with many of the protagonists still available for interview. Ron Firman and Robin Oliver are introduced here and a rare example of contradictory error in the book – confusion over their relative ages – simply serves to emphasize the generally high editorial standard that pertains elsewhere. These two, together with G. H. Mitchell, significantly advanced knowledge of the volcanic rocks through into the mid-1950s, but from here it has been impossible for the author to maintain strict chronological continuity, and Chapter 8 takes the reader back to Cambridge in the late 1890s and to Gertrude Elles' work on Skiddaw Group graptolites. The chapter develops the theme through to the modern contributions of Dennis Jackson and Adrian Rushton and, to the author's great credit, makes the arcane world of graptolite biostratigraphy both accessible and fascinating. With Chapter 9 we are back in the 1950s with the commencement of more argument, this time over the deformation sequence and the relationship of the Skiddaw Group to the Borrowdale volcanic rocks. A London faction (Alexander Simpson, Douglas Helm, Brin Roberts) is pitted against a Sheffield/Birmingham faction (Jack Soper, Frank Moseley, David Roberts); Moseley and Soper were to become particularly influential.

By this stage in the story the reader has already been exposed to a slightly bewildering multitude of geological characters and from here on the players multiply exponentially. Somehow though, Professor Oldroyd maintains both logical progression and the momentum of his story, and still manages to bring through a coherent geological exposition. This happy combination continues through chapters devoted to the first applications of plate tectonic theory to Lakeland interpretations, geophysical modelling, and a range of 1970s doctoral theses. There is then another step back in time to catch up on twentieth century work in the south of the Lake District, on what is now known as the Windermere Supergroup. And here we also move into a new phase, with the requirement for collaboration between research groups with different agendas. There's plenty of scope for aggravation in marriages of scientific convenience and Professor Oldroyd makes the most of it.

Collaboration between the British Geological Survey and various university teams, in different parts of the Lake District, is covered in Chapters 14 to 17. Is this scientific history or geological soap opera? I'm inclined to the latter view, but that's not to say that this part of the book is not an entertaining read – just don't take it too seriously. Though having said that, Professor Oldroyd draws from it all a very serious conclusion. Before reaching that point there is some scurrilous stuff to enjoy as the author builds up the magnitude of dispute and (perhaps) exaggerates the perceived personality clashes, all whilst remaining well on the right side of the libel laws. I do feel there is a tendency for

him to seek out a re-run of Sedgwick versus Murchison, with the university teams in the former role battling an overbearing and slightly malevolent government organization. I don't think many of those involved would see it in quite such simple terms. As one of the minor actors in the drama I am more painfully aware of blundering through mistakes than I am of manoeuvring through conspiracies. There are plenty of villains – you can find them for yourselves – but a few heroes too: Jack Soper gets a justifiably good press.

A couple of stand-alone chapters, Tertiary Uplift and Glaciation, intervene between the collaboration sequence and Professor Oldroyd's 'great denouement'. In some ways they break up the flow of the story but they are quite fascinating in their own right, and the latter also serves as a kind of link to the most overtly political part of the book, the chapter dealing with the background work and public enquiry into the suitability of the western Lakeland margin for a large-scale, deep investigation into the feasibility of geological disposal of radioactive waste. This is Chapter 20, 'NIREX and the great denouement'. NIREX is an acronym for the Nuclear Industry Radioactive Waste Executive.

Here we have genuine conflict and emotion as geology is cited in support of their case by both the proponents and the opponents of the NIREX scheme. The outcome is well known, but Professor Oldroyd's account raises much broader questions as to the direction of scientific research in Britain today. Whatever dust-ups and squabbles there may be along the way, science is an essentially co-operative venture. There is only ever one correct answer to a scientific problem and all of the researchers involved have the same goal – the discovery of that answer. Blinding flashes of inspiration are rare, so most discovery is a slow process, each step building on the work of those that have gone before. And in this respect there is no discredit in having explored blind alleys. To make these points clear to those who currently decide the finances and priorities of British science, the latter chapters of Professor Oldroyd's book should be prescribed for compulsory study. The effects of the science policies of successive governments are there for all to see and should not make comfortable reading for the policy-makers involved.

So, apart from the conscripted Whitehall and research council mandarins, who should voluntarily read the book? Lake District *aficionados* will love it and it will become an invaluable reference source for Lakeland geology. Anyone with a serious interest in the history of geology will find much of interest in the first half of the book (and also in the later uplift and glaciation chapters), and probably much to amuse them in the second half. Perhaps more importantly, working geologists should take a long hard look at this informed and scholarly, outsider's view of how we go about our business. There are certainly morals to be drawn and at a generic level this account of work in the Lake District probably illustrates what goes on elsewhere. From that point of view it deserves a wide readership, certainly beyond geologists with the titular regional interests. The organizational problems facing geology today are not unique after all and there are messages here for other branches of science.

On a lighter note, it's fun to pick the winners. From the multitude of geologists contributing to Professor Oldroyd's story, which ones might get a mention in any history of Lakeland geological research written a century hence? Is it a vain hope that we will have ceased our fascination with controversy, and instead hand out the accolades to the champions of co-operation? Probably.

Phil Stone