BOOK REVIEWS

McGOWRAN, B. 2005. *Biostratigraphy. Microfossils and Geological Time*. xx + 459 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £50.00, US $85.00 (hard covers). ISBN 0 521 83750 2.
doi:10.1017/S0016756806212482

Biostratigraphy is a curiously undervalued science these days. Whereas an improved or new high-technology methodology for deriving numerical or chemostratigraphical ages for deposits would attract global attention and acclaim, biostratigraphical innovation and expertise is effectively taken as read. Nobody gazes with awe and wonder at the palaeontologist who provides them with the age of the rocks they are studying.

It is in this context that McGowran sets out to assess the place of biostratigraphy in the modern scientific enterprise. In his Preface he asks 'Is there any more to biostratigraphy than . . . determining fossils and testing their constant ranges, over and over again. . .?' Are biostratigraphers forever locked in a dead-end inductive cycle, isolated from the excitement of hypothesis-driven research? It's a bleak thought, and McGowran sets out to demolish it in this extended review of all things biostratigraphical. He combines an exhaustive examination of the roots of the discipline with an assessment of theory and practice in the modern world, exploring how new developments in geology and biology affect (or don't affect) biostratigraphy and how detailed biozonations are an integral part of the investigation and interpretation of biogeohistory. His central theme is that we have to ask repeatedly if we have got the correlations right – if not, how can we hope ever to get the geological or biological history right?

So, the rationale of this book is clear, although it's perhaps less obvious for whom it's intended. Evidently, it should be read by practitioners, but whether it will manage to gain the attention of the downstream users of biostratigraphy, or of the scientists who collaborate with the fossil specialists, is more moot. Large parts of the text are difficult to follow without a pretty intimate knowledge of Cenozoic foraminifera, and some of the long historical/philosophical discussions are clearly for the aficionado. There is more than a whiff of era and group chauvinism here; we are told that the Cenozoic is the most interesting age, and the foraminifera, particularly the planktonic ones, the most important fossils. Many researchers, of course, would have their own issues with this, but there is some justification for this attitude in the major advances that have been made in Cenozoic geohistory through the various phases of the international ocean drilling project. The development of the integrated magnetobiochronological timescale is a huge step forward, and is being carried further by the incorporation of chemostratigraphy and cyclostratigraphy. This approach can't all be exported back into the earlier Phanerozoic, but I, for one, have been confronted with many possibilities to consider while I have been reading this book.

In many ways, this volume is the 21st century successor to Shaw's 1964 classic *Time in Stratigraphy*, although McGowran ascribes to a worldview that is arguably opposite to Shaw's. But if we view the development of biostratigraphical science as evolutionary rather than revolutionary, then this is a worthy descendant. Where Shaw promoted the dictum that 'all laterally traceable nonvolcanic epeiric marine sedimentary rock units must be presumed to be diachronous', McGowran emphasizes the lateral persistence of sedimentary surfaces, the importance of recognizing and correlating sequence breaks, and the constraining of diachrony within one sequence. Indeed, the development of sequence stratigraphy provides us with a theoretical paradigm within, and alongside, which we can generate and test biostratigraphical hypotheses. Although it might be dangerous to tie the future of the science to just one framework, the wider backdrop of climate change, ocean/atmosphere interaction, supervolcanicity, bolide bombardment and sea-level fluctuation provides a setting in which the detailed work of the biostratigrapher can flourish. To plagiarise McGowran's own final sentence: Biostratigraphy lives!

Richard J. Aldridge

LEGROS, J.-P. 2006. *Mapping of the Soil.* First published 1996 as *Cartographie des Sols* by Presses Polytechniques et Universitaires Romandes, Lausanne. Translated from French by V. A. K. Sharma. xv + 411 pp. Enfield, Jersey, Plymouth: Science Publishers. Price £42.00 (hard covers). ISBN 1 57808 363 X.
doi:10.1017/S0016756806222489

This methodological textbook provides a readable and detailed overview of the multifaceted science and art that is soil mapping. Recently updated by the author, and translated by V. A. K. Sarma from the original 1996 French version, this helpful book is now available to the English speaking world. Beginning with general definitions and descriptions of the basic approaches employed to map the soil resource, the author describes in detail most aspects involved in the creation of a soil map and some subsequent applications. The uses of soil maps are examined, basic pedological concepts are explained and these provide a context for this work.

While there is an understandable emphasis on the French/Francophone procedures of soil survey, this book is inclusive of alternate strategies, outlining numerous styles of mapping and soil information systems used in various countries and internationally. The methods of soil mapping described in this book are diverse. The evolution of the science and technology is evident throughout and resultantly some techniques, especially those describing data entry, seem rather out-dated. Nevertheless this text provides a helpful digest of a range of methodologies from which a customized survey using modern technology can be created.

The planning of field work chapter covers almost everything which could be required, from contractual arrangements to landowner-placation, as well as more obvious desk techniques, equipment descriptions and time and cost calculations. The basic principles of field soil descriptions are outlined to demonstrate that soil descriptions are based on science, but specific national classification systems are not provided in any detail. Anyone seeking to undertake a soil survey should also obtain the relevant books on the classification they are using.

Multiple techniques of map preparation, boundary detection and unit delineation are provided. Paper-based methods dominate, but the same principles apply to both raster- and vector-based GIS systems which are both briefly overviewed in a chapter on computer processing. The slightly subjective nature of mapping is highlighted and a range of quality control, accuracy and evaluation methods and calculations is provided. Sample analysis pre-treatment is mentioned, and map layout and legend design is touched upon.

Digital input of soil data from historic surveys is described by reference to a French system, and brief description of some international soil data management systems are provided, though on the author's own admission the review is 'far from being exhaustive'. The chapter on soil modelling clearly shows signs of updating since the first edition of this book, and many of the references will provide the reader with a starting point for the deepening of their understanding of this progressing subject. Different methods of modelling are touched upon and will educate the reader as to the basics of some methods used in digital soil mapping.

With reference to soil, the advantages and disadvantages of thematic mapping are considered. Thematic mapping is examined both as a derivative of soil maps (for example, crop suitability) and also, in the case of other environmental layers, in comparison with soil maps (i.e. how does soil influence ecosystems?). The chapter on using soil information in multi-disciplinary approaches outlines a number of agronomic, engineering, ecological and climatic projects in which soil data have been successfully incorporated.

This book is targeted at soil scientists, soil cartographers and university students, though its use should not be so limited. Because of the international scope of this text there are bound to be techniques described which are new to all but the most experienced soil surveyors. Anyone involved with soil maps would benefit from sections of this book, as it clearly outlines many issues which must be faced when trying to map the soil. Like any map, the more one understands the subject being mapped, the better the use of the end product. This book will help anyone better to understand the mapping of soil, and comes highly recommended.

T. S. Farewell

POLLARD, D. D. & FLETCHER, R. C. 2005. *Fundamentals of Structural Geology*. xii + 500 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £45.00, US $80.00 (hard covers). ISBN 0 521 83927 0. doi:10.1017/S0016756806232485

As with many fields of Earth science, there are two philosophically different ways of understanding the inherently complex processes of structural geology. One way is essentially holistic, involving the field observation of a whole deformed rock body, but often revealing a complexity not easily analysed quantitatively. The other approach is reductionist, isolating the component structures of a deformed body in such a way that they can be idealized and modelled mathematically. It is now nearly forty years since John Ramsay (1967, *Folding and Fracturing of Rocks*, McGraw Hill) made a quantum leap in promoting the rigorous understanding of geological structures. Most undergraduate structural geology courses have since included some quantitative elements. However, these elements have become, in the UK at least, more challenging to teach as the mathematical confidence of the average university entrant has declined. Against this background, *Fundamentals of Structural Geology* is a renewed attempt to make the quantitative approach to structural geology more accessible. David Pollard and Raymond Fletcher are, however, realistic enough to target their book at 'advanced undergraduate and graduate students and researchers'.

For this target readership, I cannot better the description of the book on its back cover as `refreshing'. It is organized in a novel but thought-provoking way, starting with a motivational chapter of case studies and finishing with one on the methodology of structural geology. In between, we are taken first through geometrical concepts and then dimensional analysis and scaling. Next we deal with deformation and flow, force and stress, and conservation of mass and momentum, before focusing on elastic and brittle behaviour, then viscous deformation. The approach is uncompromisingly quantitative throughout, though the maths is very clearly explained and illustrated. Most readers with some basic calculus and physics should, with perseverance, be able to work their way through most chapters. However, true to the book's aim of bridging the gap between observation and theory, there are also field-based case studies in most chapters, some of them familiar to readers of the authors' research papers. Some chapters are also lightened a touch, by portraits of the historical heroes of continuum mechanics. The text style is as engaging as the subject matter will allow, and the illustrations are clear and well chosen. In the modern fashion, there is a related website containing colour images, supplementary photographs, datasets and worked exercises, a site which is well organized and useful for students and teachers alike.

The authors are right that few introductory structural geology courses will use this book, but it deserves good sales to more advanced users. Graduate students and research geologists, in particular, will find it a clear and reliable source of good practice and good sense on quantitative structural geology.

Nigel Woodcock

HODGSON, D. M. & FLINT, S. S. (eds) 2005. *Submarine Slope Systems. Processes and Products*. Geological Society Special Publication no. 244. v + 225 pp. London, Bath: Geological Society of London. Price £65.00 (hard covers). ISBN 1 86239 175 0. doi:10.1017/S0016756806242481

This collection of papers is one of the more slimline volumes in the Geological Society Special Publications series. It contains a dozen contributions, plus a short introduction by the editors, and stretches to just over 200 pages. However, if judged in terms of quality and diversity of content, rather than by weight of the bound volume, it scores quite highly.

Older literature on depositional environments has tended to 'by-pass' the zone between the shelf and the ocean floor, in much the same way that a lot of sediment was assumed to by-pass the continental slope, but this volume firmly establishes that submarine slopes can be important regions of deposition of a variety of deposits by a spectrum of processes. Mass-transport processes dominate, but sediment bodies range from thick mudstones to structureless sandstones, to olistoliths (which may include fragments of carbonate shelves) and slump and slide units. The strata may be host to hydrocarbons, and this has no doubt provided an incentive to more detailed and comprehensive studies of slope deposits. They are also environments which are sensitive to changes in relative sea level, either eustatically or tectonically induced,

and as such provide a record of sea level fluctuations which complement similar studies on the shelves, providing a link to the responses seen in basin-floor depositional systems.

The strength of this volume really lies in the diversity of the papers and the different approaches of submarine slopes that they represent. The editors set the linking of modern processes with ancient examples as their goal, and this they have achieved. Outcrop studies are from SE France, Namibia, Turkey, the Spanish Pyrenees and southern Chile. It is the last of these which catches they eye for the spectacular photomosaics of hillside outcrops at seismic scale which superbly illustrate a mass transport complex of slide blocks and debris flows. Equally impressive are some of the side-scan sonar images from offshore Costa Rica which provide an alternative perspective on the scale of slump scars and associated debris flows on the slope of an ocean trench. 2D seismic data from the Gulf of Cadiz, Spain, and 3D data from offshore Congo form the basis of two other case studies, and there is a paper based on borehole images of slope strata from the North Island of New Zealand. Ocean Drilling Program data are utilized in the study of the evolution of an accretionary prism slope in the Nankai Trough offshore Japan. To complete the range of locations and approaches there is a paper on the erosion of continental slopes using data offshore of Virginia, but taking a more numerical approach to the issues.

This volume may be fairly lightweight in a literal sense, but as a collection it provides a valuable mass of literature on submarine slope systems. Anyone interested in marine sedimentary processes and products will find this interesting, and those looking for models for exploration in submarine depositional systems should find it an essential reference.

Gary Nichols

PURNELL, M. A. & DONOGHUE, P. C. J. (eds) 2005. *Conodont Biology and Phylogeny: Interpreting the Fossil Record*. Special Papers in Palaeontology no. 73. 218 pp. London: The Palaeontological Association. Price £66 (paperback). ISBN 0 901702 97 8; ISSN 0038-6804.
doi:10.1017/S0016756806252488

The volume is a collection of papers arising from a symposium ('Bias and Completeness in the Conodont Fossil Record') held at the ECOS VIII (Eighth International Conodont) Symposium held in Europe in 2002. Some of those who were invited to contribute talks at the scientific session have also submitted manuscripts to this volume.

The book updates earlier reviews on conodont techniques but also brings up new timely topics. Biases in the fossil record can be due to features or mechanisms predating or postdating the collecting or during the collection process itself. The Editors start with a useful review of possible biases and then the invited contributors present their cases.

Armstrong successfully argues that conodont elements were not shed or replaced during life, and van Bitter & Purnell continue with an illuminating case of how post-depositional taphonomic processes such as diagenesis can bias our understanding of conodont apparatuses. Jeppsson provides excellent advice on laboratory techniques in order to diminish biases due to unreliable lab standards.

Orchard tells an inspirational story of systematics in the Triassic Gondolelloidea. Revision can here be based on 'uninteresting' or 'unimportant' element types if/when these are, indeed, recovered and identified. Barrick & Männik competently deal with sequence stratigraphy biases, while Lehnert *et al.* address the missing record due to sea-level fluctuations, sequence boundaries and unfavourable lithologies. They really convince us that there is still a lot of information to collect out there! Walt Sweet inspires us to make our data useful for graphic correlation and to use this technique more often.

The last three contributions deal with biases due to the incompleteness even of continuous stratigraphic records. First, the stratophenetic approach is discussed theoretically by Roopnarine, who concludes that hypotheses of genealogical descent must be formulated independently of stratigraphic order. A tough order, indeed, for those of us who are biostratigraphically inclined. Stratophenetic practice is very eloquently and convincingly defended by Dzik, who exemplifies his views by a beautifully illustrated tale of the Palmatolepididae in the Frasnian–Famennian of the Holy Cross Mountains of Poland. A cladistic evaluation of *Kockellella* is presented by Wickström & Donoghue. This is elegant; the conclusions are probably true, but the essay may be a bit too theoretically inclined for many practitioners. It would have been more palatable with better illustrations – and why not replace one of the Tables in the Appendix with a photo or drawing of *Kockellella*?

In all, this is a volume for everyone interested in conodonts – and many more. The Editors are congratulated for an excellent job. Efforts like this should be encouraged to recur – I'm sure there are a lot more possible contributions for a Volume 2.

Anita Löfgren

FRANKEL, C. 2005. *Worlds on Fire. Volcanoes on the Earth, the Moon, Mars, Venus and Io*. viii + 358 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £25.00, US $40.00 (hard covers). ISBN 0 521 80393 4.
doi:10.1017/S0016756806262484

Charles Frankel's excellent *Volcanoes of the Solar System* (Cambridge University Press, 1996) is now out of print. This book, by the same publisher, is clearly intended as its successor. Comparing the two, it is not difficult to find passages of text and illustrations that they share in common. However, the new book is considerably updated, notably in being a post-*Galileo* account of the volcanism of Io and in including some recent high-resolution images of Martian volcanic features. The glossary, absent from the previous book, will be of benefit to readers unfamiliar with terms such as hyaloclastite and tholeiite. However I was surprised to see a glossary entry for 'vacuole', defined as 'cavity created in lava rock by the expansion and escape of gas bubbles'; to me, this is a 'vesicle', and indeed 'vesicle' but not 'vacuole' appears in the index. In the text the Icelandic term jökulhlaup (glacier burst) is wrongly presented as synonymous with lahar (volcanogenic mudflow), and is never spelled correctly (it appears as either jökullaup or jökulhaup).

The structure of the book is to give a general overview of volcanism on a particular planetary body, and then to describe visits to particular volcanoes on that body in the next chapter. Thus there are ten chapters, in five pairs, covering the Earth, the Moon, Mars, Venus and Jupiter's volcanically active moon Io. In a departure from the previous book, there is no discussion of icy volcanism (cryovolcanism) on other outer planet satellites.

The first chapter introduces volcanism in general, and perhaps gives sufficient background for non-volcanologists to appreciate the rest of the book. The volcanoes 'visited' in Chapter 2 are Krafla, Kilauea, Etna, Ol Doinyo Lengai and Mount (*sic*) Pelée in Martinique. There are no maps and only three or four photos each, so these descriptions are certainly inadequate as excursion guides although they do whet the appetite and are a pleasant way to reminisce if one has already visited some of these. I suspect that the true value of the book is to be found in the similar-length accounts of extraterrestrial volcanism and volcanoes in the following eight chapters.

I found the lunar volcanism chapter informative and well written. The five lunar volcanic field trips, imaginatively described in Chapter 5, begin with two of the actual Apollo landing sites (Hadley Rille and the Taurus-Littrow valley), then a deleted Apollo site (the Marius Hills), and finally the Gruithsen domes (unusually steep lunar volcanic constructs) and the rilles of the Aristarchus plateau. These are fun to read, but sadly only one of the orbital images of the lunar surface includes a scale (a flaw that recurs far too often later in the book as well).

I enjoyed the imaginary tours of Martian volcanoes, though I would have liked to be taken to an example of a small volcanic feature in place of one of the succession of five giant volcanoes. The excursions on Venus are more varied, but for me the best chapter in the book is the one describing volcanism on Io. This is a lucid account of how ideas and knowledge evolved as the initial Voyager observations were followed by new telescopic data and then a succession of encounters by the *Galileo* probe.

At the end I am left with the impression that this book is a flawed masterpiece. I will certainly refer back to it when seeking ideas or inspiration.

David A. Rothery

HAMMER, Ø. & HARPER, D. 2005. *Paleontological Data Analysis*. xi + 351 pp. Oxford: Blackwell Publishing. Price £39.99 (paperback). ISBN 1 4051 1544 0. doi:10.1017/S0016756806272480

Published in October 2005 (rather than 2006 as indicated on the copyright page) this book represents the culmination of a process that started in the late 1980s with the production of a software package (PALSTAT) of numerical statistical techniques appropriate for palaeontologically-oriented problems. This has been elaborated subsequently in the form of regularly updated freeware known as PAST (**PA**laeontological **ST**atistics – that first appeared in 1998) that includes a wide range of statistical packages relevant to palaeontology: univariate/multivariate statistics, ecological data analysis, morphometrics, phylogenetic analysis, time series analysis, etc. The program manual for PAST is rather terse and assumes some level of prior knowledge, or familiarity, with the packages. This book is not terse but is in fact very accessible and practical (with a view to acting as an undergraduate course guide), and is intended to be most definitely a *primer* in mathematical techniques rather than a sole authority and works cohesively with PAST.

In keeping with the broad-ranging and necessarily multidisciplinary nature of palaeontology, this book attempts to provide an equally broad-ranging review of data analysis and its practice. The authors have culled, from published sources, a wide variety of examples that are both illustrative and, on occasion, illuminate spectacularly some of the pitfalls associated with taking interpretation, based on such mathematical techniques, a little too far. The subject matter covered is prefaced by a neatly structured introductory chapter outlining the value, and obvious pitfalls, associated with data and its collection; and the need for a rational approach to a perceived problem rather than taking a 'scatter-gun' approach (pointing to the understandable but inevitable tension that exists between those who enjoy statistical modelling for its own sake and those who do not).

Beyond this point the book proceeds to offer a discussion of the rationale behind, and pitfalls associated with, discerning trends or patterns in data sets sampled from palaeontological collections. Firstly basic techniques are outlined – ones indeed associated with distinguishing between groups of data to determine the extent to which such data contain embedded differences that may be of value in determining the limits to, for example, taxonomic units ('species'). As a consequence basic techniques associated with statistical sampling and 'difference' dominate consideration with some nicely worked examples. Beyond this point, multivariate techniques are explained and lead on fairly naturally to a long section on morphometric techniques and their implementation. There is then a change of pace with a shift across to numerical techniques associated with phylogenetic analysis; this area is covered rather briefly, albeit succinctly, and leads into a chapter on biogeographic and ecological modelling techniques followed by time series analysis and quantitative biostratigraphy. Brief appendices on plotting techniques and mathematical notation complete the volume, apart from the invaluable bibliography that allows this primer to be a genuine stepping stone.

All in all this is to my mind an excellent book. It is neither comprehensive nor definitive (but the book never claims to be so) yet the examples chosen work well, and are explained with admirable clarity. This book would be very valuable if adopted as a standard undergraduate course primer in 'data analysis techniques for palaeobiologists' either toward the end of a standard second-year course (usually in Geology or Earth Sciences) or at the beginning a third year, especially if major palaeontological projects/dissertations are an integral part of the overall degree course.

David Norman

DAVIES, R. J., CARTWRIGHT, J. A., STEWART, S. A., LAPPIN, M. & UNDERHILL, J. R. (eds) 2004. *3D Seismic Technology. Application to the Exploration of Sedimentary Basins*. Geological Society Memoir no. 29. viii + 355 pp. + CD-ROM. London, Bath: Geological Society of London. Price £85.00, US $142.00; GSL members' price £42.50, US $71.00; AAPG/SEPM/GSA/RAS/EFG/PESGB members' price £51.00, US $85.00 (hard covers). ISBN 1 86239 151 3. doi:10.1017/S0016756806282487

3D seismic data are providing geoscientists with a new view of the sub-surface. There is now much greater awareness of the benefits they offer as a result of more data becoming publicly available in recent years. They take us beyond the traditional scale of the outcrop or the two-dimensional cross-section, enabling us to stand back and view the geology in its entirety; small-scale features can be viewed in their proper context almost simultaneously. As the editors of this volume point out in their introductory paper this new-found access to the intricacies of the subsurface should be being used to challenge and redefine existing paradigms.

3D Seismic Technology: Application to the Exploration of Sedimentary Basins was published in 2004 and arose

from a conference held in 2001. It is very well produced by the Geological Society of London as one of their series of Memoirs, and good use is made of the large A4 format for reproducing some spectacular images of the subsurface as revealed by 3D data. It contains 32 papers, some of which are enhanced with further illustrations (movies) on a CD-ROM.

Following an introductory paper which explores the potential of 3D seismic data, the book is divided into four sections. Nine papers on 'Depositional systems' illustrate how 3D seismic data can provide a better understanding of stratigraphy, through knowledge of the spatial relationships of different seismic facies. There are some superb illustrations of sedimentary structures on the present sea floor and preserved in the sub-surface. One of the benefits of being able to manipulate 3D data on a workstation is that it is possible simultaneously to view ancient land surfaces and cross-sections through them. These can be compared with what we see preserved in the field, thus enhancing our interpretations of outcrop geology.

There are ten papers in the section on 'Structural and igneous geology'. 3D seismic data have enabled structural geologists to test and in some situations validate many of the ideas about the geometries and displacements of faults that were developed in the 1980s and 1990s. It is perhaps surprising that data designed for imaging the sedimentary record have provided an impetus to studying the emplacement mechanisms of igneous rocks. However, the advantages of being able to view the geometry and interrelationships of intrusive bodies in 3D over a range of depth far greater than ever seen in outcrop is used to good effect in two papers considering the intrusion of sills.

The initial cost of 3D data meant that they were first used in planning the development of reservoirs, and seven papers in a section on 'Application and development at production scale' return to this use of the data. In particular, they illustrate the application of the various visualization tools available to the 3D seismic interpreter, and how these can be used to combine data from wells and physical property information derived directly from the seismic data to provide an informative model of the subsurface on which critical engineering decisions are often based.

The final section of the book is entitled 'New applications'. This section of five papers looks at a diverse range of topics of which the comparison of surveys acquired over the same site at different times, so called 'time lapse' or 4D surveying, is perhaps the most notable. This technique has immense potential for monitoring changes in the sub-surface environment. There then follows a useful index and the CD-ROM containing movies which provide enhanced illustration of four of the papers. These worked well and served to better illustrate some of the more complex structures in the seismic data or models derived from the data. If I have one criticism it is that you need to have the book to hand for an explanation when viewing the movies. It might have been better if the movies had been embedded in pdf versions of the text.

This is an excellent book for anyone interested in the applications of seismic data. Seismic data are too often considered the domain of the geophysicist. Some basic geophysical knowledge is certainly necessary to get the most out of the data and be aware of the limitations but this source of subsurface data should be explored by all Earth Scientists, be they stratigraphers or volcanologists. Then some of those paradigms might be challenged. . .

R. W. England

DE BOER, J. Z. & SANDERS, D. T. 2004. *Volcanoes in Human History. The Far-Reaching Effects of Major Eruptions*. xix + 295 pp. Princeton: Princeton University Press. Price £12.50 (paperback). ISBN 0 691 11838 8.
doi:10.1017/S0016756806292483

This book takes a different stance from most books on volcanoes by focusing on the interaction between volcanoes and the human population. It does this in terms of different scales both in time and in space. The impact of eruptions on the adjacent human community is described as well as, in the case of larger events, regional and global implications. Much attention in the literature has been devoted to describing famous eruptions, including many of those considered in this book, but how communities respond and adapt to the aftermath is not so well reported. The structure of the book is based on nine case study examples. The first chapter provides a context to volcanism within the earth sciences with a brief description of volcanic processes. This chapter is brief, well presented and achieves the right balance between being scientifically sound without sinking the reader in technical jargon and detail.

The first case study chapter is on the Hawaiian Islands and starts with a description of how the Hawaiians believed that the volcanic eruptions were the work of goddess Pele, and that the islands were built up through the interaction of her powers and those of her sister, Namaka o Kahei, the goddess of the sea. The main island of Hawaii is an appropriate place to start as the shield volcanoes of Mauna Loa and Mauna Kea are among the largest topographic features on the surface of the solid Earth and yet were built up over a very short period of time, a clear demonstration of volcanism as a manifestation of a dynamic planet. The tectonic setting of the Hawaiian Island chain and its formation as the Pacific plate moved north-westwards over a hot spot formed by a mantle plume is described. This is followed by a discussion of the volcanic activity of Kilauea and Mauna Loa during the 19th and 20th centuries. The next chapter moves to the Mediterranean and deals with a single eruption, the Bronze Age eruption of Thera, the largest of the Santorini Islands. The Bronze Age eruption of Thera was the largest volcanic event in Europe to have occurred in the last 5000 years and it seems to have had an important influence in the development of civilisation in the Mediterranean basin. This chapter looks at the evidence that supports the proposition that the eruption contributed to the demise of the Minoan civilisation. Tectonic earthquakes that preceded the eruption did much damage to Minoan sites in Crete; tsunamis generated by caldera collapse and pyroclastic flows entering the sea would have caused devastation along the shores of Crete destroying capacity for maritime trade. Archaeological studies also indicate damage by fire in Minoan sites on Crete but how this was caused by the eruption of Thera is unclear. In the palace at Knossos there is archaeological evidence that in the late Minoan period Linear A script gave way to Linear B, which has the same syllabic script as Linear A but is an archaic form of Greek. This it has been argued reflects the invasion of Mycenaean Greeks into Crete and the end of Minoan dominance. This chapter provides a fascinating discussion of the possible influence of the Thera eruption on the demise of the Minoans, the ascendancy of the Mycenaeans and Greek civilisation and the legends of Atlantis and the Old Testament. On a more pragmatic note, the pumice quarried from Thera makes excellent hydraulic cement and made a valuable contribution to the construction of the Suez Canal.

The AD 79 eruption of Vesuvius has a central place in volcanology both in terms of eruptive processes (plinian

eruptions) and impact on human communities (engulfing the Roman towns of Pompeii and Herculaneum). 'The eruption of Vesuvius in 79 C.E.: cultural reverberations through the ages' is, therefore, an appropriate chapter title. The importance of study of Vesuvius in setting the foundation for the science of volcanology is presented. Sir William Hamilton was pivotal in this as a student of the activity of Vesuvius, and made numerous scientific presentations to the Royal Society of London and published the classic book, *Campi Phlegraei.*

Iceland, like Vesuvius, has played an important part in contributing to the education of the human race in the role of volcanism as a planetary process of the Earth. After some initial geological-scene setting this chapter begins by describing how volcanic activity clearly influenced early visitors and settlers and became interwoven in the myths of early Icelandic literature. It was the eruption of the Laki fissure in 1783 through to 1784 that brought Icelandic volcanism to the attention of the wider community. The hot summer in England and western Europe in 1783 had a "peculiar haze, or smoky fog" which was probably due to gases such as carbon dioxide given off by the eruption accumulating in the lower atmosphere causing a greenhouse effect. By contrast the injection of sulphur dioxide to higher altitudes forming aerosols which blocked incoming solar radiation led to a much colder winter in Europe and North America. Benjamin Franklin made the perceptive observation linking the anomalous climatic conditions with the impact of the eruption in Iceland. The consequences of the eruption may have been severe in Europe and North America but they were devastating in Iceland. The ash and droplets of acid rain, formed from the sulphur dioxide, damaged grazing, fluorine poisoned waters and more than half of Iceland's cattle, sheep and horses died. The other main source of food, fishing, was curtailed as a consequence of the cold winters that followed the eruption. More than a quarter of Iceland's population of 50,000 died as a result of the impacts of the eruption. This is a stark example of the vulnerability of island communities to natural disasters.

The next two chapters are concerned with Indonesia. The archipelago of Indonesia contains at least 76 volcanoes that have been active in historic times. Two of these volcanoes have given rise to eruptions that dominate any list of volcanic natural disasters – Tambora and Krakatau. It is also worth remembering that the Toba eruption, VEI 8, of about 75,000 years BP, was the 'super volcano' event of the last 100,000 years and that Toba is also in Indonesia. Yet the fertile volcanic soils in this tropical climate support a high population density. The eruption of Tambora in 1815 was one of the largest volcanic events in historic times and caused widespread local devastation killing tens of thousands of people on the islands Sumbwa and Lombok. The eruption, however, is best known for its impact on global climate with aerosols injected high into the stratosphere which spread around the world, leading to a two- to three-year period of weather extremes following the eruption. In the northern hemisphere it led to cold and wet summers, particularly in Europe and North America, and it is estimated that more than 100,000 people died of famine or disease. Sixty-eight years later the volcanic island of Krakatau, lying between Java and Sumatra, erupted in 1883 with devastating consequences. This is an excellent account of the impact of the volcano on the communities of the adjacent islands. The description of the damage caused by the tsunami is particularly evocative at the present time following the 2004 Asian tsunami. The chapter ends with an interesting account of how plants and animals became re-established on the barren substrate of the remnant islands after the eruption and how the ecology has developed and matured through time.

The eruption of Mount Pelée on the island of Martinique in 1902 is an essential part of any account of the impact of volcanic activity on a human community. As such it features in most volcanology books but deserves a place here. The chapter on the eruption of Tristan da Cunha gives an interesting insight into a relatively small eruption but which occurred literally in the back yard of the only settlement on what must be one of the most isolated islands in the world. This is a valuable discussion of an eruption that is not well described in the literature. It would have been helpful if the primary account on the eruption by Peter Baker *et al.* (1964) had been included in the references.

The final chapter on the eruption of Mount St Helens in 1980 is a fitting conclusion to the book. Mount St Helens 1980, taking place in the politically and economically dominant nation in the world, had a major impact well beyond the scientific community. This was a well studied volcano and points up the issues of having a good hazard assessment and yet being able to translate this through the civil, political and social infrastructure to bring about effective risk mitigation. Not only did the eruption set scientific agendas in volcanology but stimulated research in diverse fields influenced by the volcanism. This account provides an interesting outline of some of the broader issues such as the dislocation to communities affected by ashfall, the economic and social dislocation of the local community, ecological adjustment and the inspiration to artists. The eruption was an important illustration of the impact of a natural disaster on a major developed country.

This is a modestly priced book which I would recommend as an enjoyable read to all interested in the impact of volcanism on people.

Angus Duncan

Reference

BAKER, P. *et al.* 1964. The volcanological report of the Royal Society expedition to Tristan da Cunha 1962. *Philosophical Transactions of the Royal Society of London* **256**, 439–578.

MORAWIEC, A. 2004. *Orientations and Rotations. Computations in Crystallographic Textures*. x + 200 pp. Berlin, Heidelberg, New York: Springer-Verlag. Price Euros 59.95 (+ VAT at local rate), SFr 106.00, £46.00, US $79.95 (hard covers). ISBN 3 540 40734 0. doi:10.1017/S0016756806302488

The Earth is made mostly of crystalline materials. Due to their lattice geometries, all crystalline grains are anisotropic and hence their orientations influence many physical properties such as strength, seismic velocity and optical properties. The difference in lattice orientation between two adjacent grains – the misorientation – gives key information on the nature of the boundary between those grains and insight into how the boundary formed. The mathematics of orientation, which this book addresses in great detail, is therefore very relevant to Earth science.

It begins at a very fundamental level, discussing various representations of rotation – the easiest to understand being the definition in terms of a rotation axis (of unit length, defined then by two numbers) and an angle defining the

amount of rotation. There are other choices of three numbers to define rotation, which facilitate algebraic manipulations, or one might even choose a unit vector in four dimensions (a quaternion). Superimposed rotations combine in a very non-linear way and this gives rise to much of the mathematical richness which follows. Given that a rock contains many grains, the notion of 'average orientation' is addressed – it sounds simple but isn't. By Chapter 6 the author is ready to introduce a discussion of crystal symmetry, which has a profound effect since mathematically different rotations can give rise to indistinguishable lattices. He then moves on to discuss misorientation, addressing issues such as the distribution of misorientation angles obtained for a random distribution of crystallite orientations. The answers here underpin misorientation analysis which is particularly relevant for understanding how microstructures develop during deformation. We then learn about how non-random distributions of orientation can be analysed statistically. In Chapter 10 – rather late on, from a practical point of view, but logical – we are introduced to how one might actually measure orientations using diffraction techniques. The book closes with a chapter on calculating effective (bulk) elastic properties from distributions of orientations.

Although there is a huge scientific context for this topic, the book is uncompromisingly mathematical. There are no 'case studies' illustrating applications of the mathematical framework, nor is it always easy to see where the analytical development is leading. In Earth Science, the study of microstructure has been stirred up in the last decade by application of Electron Backscatter Diffraction to map out crystal orientations. The calculations of orientation from a diffraction pattern obtained at each point, and subsequent analysis of such orientation data, are underpinned by mathematical relationships given in this book. However those key equations are well camouflaged in a mass of analysis which might appeal more to a pure mathematician than to an applied mathematician, let alone an Earth scientist. I will certainly use it as a reference, but on the basis that I already have a working knowledge of the subject. It would not, I suspect, be an easy introduction to the subject for someone with little prior knowledge, and certainly does not give its geological context. Despite these remarks, the book is a detailed and careful treatment of the topic which pulls together many pieces of work previously scattered through the literature, and makes a coherent whole.

John Wheeler

DEER, W. A., HOWIE, R. A., WISE, W. S. & ZUSSMAN, J. 2004. *Rock-Forming Minerals. Volume 4B. Framework Silicates: Silica Minerals. Feldspathoids and the Zeolites*, 2nd ed. xv + 982 pp. London, Bath: Geological Society of London. Price £125.00, US $209.00; GSL/IGI members' price £62.50, US $104.00; AAPG/SEPM/GSA/RAS members' price £75.00, US $125.00 (hard covers). ISBN 1 86239 144 0.
doi:10.1017/S0016756806312484

This is the eighth part of the second edition of the *Rock-Forming Minerals* and we await only two more parts (3B: Sheet Silicates: Non-Micas, and 5A: Non-Silicates: Oxides, Hydroxides and Sulphides) to complete the set. For the current volume the famous trio was joined by Professor W. S. Wise, of the University of California at Santa Barbara, who helped share the enormous load in revising this volume. At near 1000 pages, it is more than twice the size of the whole of Volume 4 in the first edition. Volume 4B covers the silica minerals, the nepheline–kalsilite group, petalite, leucite, the sodalite group, the cancrinite group, the scapolite group and the zeolites. For each mineral group the information is presented in the familiar order: a brief introduction followed by sections on structure, chemistry, optical and physical properties, distinguishing features, paragenesis and references. Information under each of these subheadings is generally quite detailed, although in the structural section they stop short of giving atomic coordinates for the structures. In this volume, as with the others, the variations in structures and properties due to atomic substitutions are treated in great detail.

The section on the silica minerals covers 152 pages (in the first edition it was 52 pages), including 25 pages of references. In a search for information on the formation of opal I found the grouping of the silica minerals together a little unsatisfactory. They are not a structural group like the others, but rather a chemical group and it might have been better if the minerals had been treated individually. The current arrangement meant switching backwards and forwards through the entire silica section, although the excellent index was a great aid.

Other sections that have been greatly expanded include the scapolite group (106 pages up from 20 pages) although the number of distinct members of the scapolite minerals has only increased by one species: silvialite, the calcium and sulphate end-member. The length of the scapolite section reflects the vast amount of new experimental, spectroscopic and thermodynamic data on these very complex minerals. The zeolites have, however, undergone the greatest change in the 40-odd year interval between the first and second editions. Not only have the number of zeolite species increased greatly (over 80 are listed in Table 22) but also there have been enormous advances in our understanding of the structures and structural relationships between species and within the group as a whole. The section starts with a very good general introduction to zeolites.

This volume is certainly up to the very high standard set by the others of the second edition and I hope that the final two parts are published soon. This second edition will have taken nearly 30 years to produce. It will undoubtedly serve mineralogists and petrologists for decades to come, but I wonder if we will ever see a third edition!

Allan Pring

MARTÍN-HERNANDEZ, F., LÜNEBERG, C. M., AUBOURG, C. & JACKSON, M. (eds) 2004. *Magnetic Fabric. Methods and Applications*. Geological Society Special Publication no. 238. vi + 551 pp. London, Bath: Geological Society of London. Price £135.00, US $243.00; GSL members' price £67.50, US $122.00; AAPG/SEPM/GSA/RAS/EFG/PESGB members' price £81.00, US $146.00 (hard covers). ISBN 1 86239 170 X.
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As a student in the 1960s I recall the admiration we felt for our mentors who had not only mastered use of the universal stage, but were prepared to spend long hours resolving mineral orientations grain by grain. The end results were very satisfying but must have left them yearning for a more rapid method for resolving rock fabrics. Nowadays of course, we have such a method in the determination of

anisotropy of magnetic susceptibility (AMS) and anisotropy of magnetic remanence (AMR). AMS remains the dominant application because measurements are fast, non-destructive and very precise. This Geological Society Special Publication brings together 26 research papers originally presented at European and American Geophysical Union meetings in 2003. By appearing exactly half a century since John Graham published a seminal paper proposing that AMS in rocks could provide a sensitive and readily-determined tool for resolving petrofabrics, it represents a Jubilee landmark. During these 50 years the technique has been found to be of very wide application because most mineral grains have a magnetic anisotropy controlled by crystallography, grain shape or both. In parallel with numerous AMS investigations specifically aimed at resolving flow directions in sediments and igneous rocks, and with relating metamorphic fabrics to strain, investigations of AMR have been conducted to establish the fidelity of stable magnetic remanence directions that form the core of palaeomagnetic analysis.

The first six papers explore developments in instrumentation and data analysis. They develop the significance of the traditional presentation of the variation in susceptibility with direction in terms of an ellipsoid and explore the range of shape parameters used to describe this approximation. Ultimately AMS records a bulk contribution of every mineral grain whether diamagnetic, paramagnetic or ferromagnetic, but in some rocks trace amounts of the latter dominate the effect and it is then possible to quantify the orientation distribution of the magnetic minerals. Other papers explore the relatively underused method of AMR determination and show how it can be combined with AMS to resolve subfabrics. Unfortunately applications to sedimentary rocks, which have probably proved most valuable to the geologist, are represented by only six papers in this book, and of these specific studies several prove to isolate tectonic fabrics. They nevertheless impressively show that AMS applied to sediments can be a sensitive tool for resolving a tectonic imprint when this would not otherwise be apparent.

Four papers evaluate magnetic fabrics in igneous rocks where AMS has proved its worth as a powerful tool for resolving magmatic flow patterns in large plutons. The specific applications pursued in this book are focused on smaller scale intrusions and volcanic rocks where the ferromagnetic signature of titanomagnetite is usually the dominant feature, although it is shown how this can also be compounded with the effect of flow-aligned paramagnetic plagioclase. The granular cause of igneous fabrics is often complex and the magnetic lineation cannot invariably be linked to flow direction. Nevertheless a correlation with magmatic flow, relaxation and post-emplacement deformation is clearly demonstrated and imbrications of magnetic lineation are also found to provide an additional flow indicator.

The dominant theme of the volume is fabric in deformed terranes, and a wide range of high quality investigations, some of which compare the results derived from magnetic methods with other techniques of fabric analysis, explore AMS and AMR in a variety of orogenic settings. It is thus to the researcher of these terranes that I would recommend this book. Magnetic fabrics are usually best defined in metamorphic rocks and we are shown how rocks such as carbonates are particularly sensitive to weak strains. However, the frequent mixture of ferromagnetic minerals (hematite, magnetite and pyrrhotite) in a host of paramagnetic phyllosilicates always produces a complex fabric. The protracted time intervals of acquisition combined with the different deformational mechanisms render it virtually impossible to relate magnetic fabric to finite strain and the link to macroscopic structures is often obscure. Hence the conclusions to studies in deformed terranes are essentially cautionary in nature: AMS and AMR can enhance our general insight into complex rocks but are usually unable to produce major breakthroughs in understanding them.

Perhaps the most significant contribution of this volume is its emphasis on the integration of magnetic fabric studies with non-magnetic applications such as neutron and X-ray goniometry, scanning electron microscopy and petrography. AMS and AMR have now become thoroughly integrated with geological investigation and are tools that no Earth Scientist can afford to ignore. The high price will, unfortunately, render this book beyond the desk of most researchers but it should nevertheless prove to be a useful library acquisition.

J. D. A. Piper

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