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REVIEWS

BOUDREAU, B. P. 1997. *Diagenetic Models and Their Implementation. Modelling Transport and Reactions in Aquatic Sediments*. xvi + 414 pp. Berlin, Heidelberg, New York, London, Paris, Tokyo, Hong Kong: Springer-Verlag. Price DM 98.00, Ös 715.40, SFr 86.50 (hard covers). ISBN 3 540 61125 8.

Many researchers will be familiar with R. A. Berner's (1980) work *The Early Diagenesis of Sediments, a Theoretical Approach*. The subject of this review deals with a similar topic, and is written by one of Berner's former students. However, *Diagenetic Models* is more than just an updated version of Berner's book, and in some senses it carries on from where Berner left off, by describing how actually to solve the diagenetic equations.

Boudreau dedicates three chapters to the construction of mathematical models describing the processes taking place in shallowly buried sediments. While the equations could doubtless be applied to the processes taking place during later diagenesis, that is not the aim of the book. Workers wishing to model processes such as quartz-overgrowth formation will find better inspiration elsewhere. However, the coverage of early diagenetic processes is comprehensive and includes diffusion, dispersion, bioturbation, compaction and fluid flow. There is a chapter concerned with kinetics (including diffusion coefficients, rate constants, tortuosity and dispersion) and a chapter on boundary conditions. As most geologists probably don't know what a boundary condition is, this chapter could prove useful! To illustrate the character of the book, Chapter 3 alone contains 198 equations, and is definitely not for the mathematically faint-hearted. The book assumes the reader to have a degree of mathematical training. A-level maths (or equivalent) would seem to be an absolute minimum, while a year or more of a university course would doubtless assist an aspiring modeller. Ph.D. supervisors who hope to include this sort of work within a project should bear this is mind!

So who will use this book? It is clearly aimed at researchers at Ph.D. level and above who wish to model transport and diagenetic processes in sediments close to the sediment–water interface. As this could loosely be termed 'environmental geology' it is a field which is likely to grow rather than otherwise. The book could well become a standard reference for the field, and is reasonably priced.

Mark Wilkinson

ALVAREZ, W. 1977. T. rex *and the Crater of Doom*. xii + 185 pp. Princeton: Princeton University Press. Price £18.95, US $24.95 (hard covers). ISBN 0 691 01630 5.

This is a book that can be profitably read by all earth scientists, and perhaps even more so by those who wish to start a lifetime of exploration in science. It is written by the son of Luis Alvarez, who led the now-famous team that first recognized the iridium anomaly in the Cretaceous–Tertiary (K/T) beds near Gubbio in central Italy. The interpretation of this iridium spike in the context of a bolide impact that triggered the mass extinction of many species, including *T. rex*, is now very widely accepted. Since then the story has grown enormously, with evidence from an astonishing range of observations that include shocked quartz, melt droplets, extraterrestrial amino acids, microdiamonds, and nickel-rich spinels. Walter Alvarez has continued to take a leading role, but the research team has grown into the hundreds, if not thousands of scientists. So what makes this book so exceptional?

Two items stand out. First is the sheer good sense and humility of the author. He deserves fame, he has earned it, yet unlike so many other scientists in a similar position, it has not been corrosive. The K/T bolide hypothesis has sparked intense controversy, and amongst those who have contributed to the debate are some who can only be described as querulous, petulant, otiose and sometimes simply poisonous. In several places in this book Walter Alvarez acknowledges the differences that have arisen, but never does he descend to insult and injury. The result, which the carping critics of the bolide hypothesis would do well to mark, is a gracious and generous book. Its other strength is to give some insights into the scientific method. Walter Alvarez describes the excitement of the chase, and also the blunders that await the unwary. Thus, at one stage when trying to find evidence for the K/T mass extinction being linked to a supernova, the Alvarez team recovered an apparently diagnostic isotopic indicator in the form of plutonium 244. By good fortune, if that it was, the Deputy Director at the Lawrence Berkeley Laboratory (where the exhaustive and exhausting analyses were carried out) told them to 'do it all over again'. This was just as well, because the first result was totally spurious, but a lesson had been learnt. Walter Alvarez is also sanguine about how the obvious can stare one in the face, yet still be overlooked. Thus, for too long the search for the impact site concentrated on ocean floor, whereas the prime candidate of Chicxulub and the surrounding zone of devastation were overlooked. But as he points out time lost was also paradoxically time gained because in the meantime other lines of evidence were piling up in support of the bolide impact. Nor should we forget that whatever the successes of this hypothesis, it leaves apparently unanswered why the many other bombardments the Earth has suffered seemingly have been less severe than the K/T event.

Of course, not everything in this book pleased, but this is not a review to be churlish and niggardly in its praise. The book is a delight to read, and should be on your bookshelf – now.

Simon Conway Morris

JOHANNES, W. & HOLTZ, F. 1996. *Petrogenesis and Experimental Petrology of Granitic Rocks*. Minerals and Rocks Series Vol. 22. xiii + 335 pp. Berlin: Springer-Verlag. Price DM 168.00, Ös 1226.40, SFr 147.00 (hard covers). ISBN 3 540 60416 2.

Experimental petrology is one of the oldest of the geological disciplines, dating from Sir James Hall's investigations in the waning stages of the eighteenth century. In the intervening years it has matured into a field of enormous scope, and one that still has much to tell us about the controls on the formation and evolution of magmatic rocks. In this ambitiously titled book, Johannes & Holtz turn their detailed attention to granitoid rocks. From the outset, a reader seeking enlightenment might reasonably expect this book to shed some illumination on the

petrogenesis of granitic rocks from around the world. In fact, although it promises much, it delivers an incomplete and almost exclusively experimental view of the idealized 'granite' world. 'Petrogenesis' is almost entirely absent from the book, despite the title, with 220 of the 300 pages of text dealing with experimental approximations to the granite system. What little geology is included is poorly explained, or incompletely described, so that after a couple of 'case studies' the reader is left bemused and unenlightened. Yet, if one wishes to find out whether an experiment on a particular bulk composition has been carried out, this is exactly the place to turn to.

This must have been a book that was hard to write. It is thorough, even compendious, in approach, with 25 dense pages of references; but it is also difficult to read and ultimately disappointing. The opening chapter 'introduction and geological background' sets the scene for the book. Not recommended for the fainthearted, or indeed for the uninitiated, this runs uncritically through granite classification schemes before providing a curiously brief motivation for the problem. Why on earth is anyone interested in granite? This book won't tell you, but it will introduce you to the Ivrea complex of the southern Alps.

The second chapter introduces the remainder of the book, which starts with the simplest chemical system that approximates to granite: 'Quartz–Albite–Orthoclase'. Subsequent chapters work through chemical variations on the theme to the system 'Quartz–Albite–Anorthite–Orthoclase ± water ± carbon dioxide', introducing the effects of minor components (P, B, F) as well as Fe and Mg on the way.

The overall character of the book is twofold: the unremitting empirical approach reminds one of a descriptive inorganic chemistry textbook: themes and patterns are poorly drawn, and it is easy to become awash in detail while losing sight of the broader perspective. At the same time the quality of the book is compromised by its intermittently dogmatic and patchily critical approach. This leads to curious contradictions: in an early chapter, one group's experimental approach is savaged, but later their data are used to illustrate a point. In Chapter three, having dismissed the idea that water contents can be determined *in situ*, the authors then cite a number of papers that have done just that. On the physical properties of melts and the way they behave in nature the authors simply reveal their ignorance.

Science apart, it is nevertheless clear that the volume was thrown together a little hurriedly, with little regard to the poor reader who might have some expectation of finding figures and text in close proximity. Citations have also been poorly checked and there are some unnecessary factual inconsistencies between chapters. The net result is highly disappointing, given the scope for producing a text of some greater value.

David Pyle

VAIRAVAMURTHY, M. A. & SCHOONEN, M. A. A. (eds) 1995. *Geochemical Transformations of Sedimentary Sulfur.* ACS Symposium Series no. 612. xi + 467 pp. Washington DC: American Chemical Society. Price US $106.95 (hard covers). ISBN 0 8412 3328 4.

The ACS Symposium Series is well known and, in the most part, consists of collections of high quality papers reflecting the current status in a particular specialist research field and resulting from a conference. This volume follows that pattern, resulting from a meeting held in Washington DC in 1994. In addition, the objective of the editors was to produce a comprehensive reference book and guide for researchers in different areas within the broad subject of sedimentary sulphur geochemistry. Thus, there is a mix of reviews and original papers within a number of themes: geochemistry of organic sulphur and of iron sulphides in sedimentary systems; oxidative transformation of hydrogen sulphide; sulphur speciation; biogeochemical transformations; isotopic effects; and thermochemical sulphate reduction. Some of the themes are represented by only two papers so do not give the review component hoped for, and the volume does not achieve the status of a reference book. The reviews are not all clearly identified and, in several cases, it is difficult for the reader to know what is commonly accepted science and what is new work. Certainly, the volume provides access to this research field through the various chapters (whether specialist or general) and the literature cited (although, as with other ACS volumes, the titles of cited literature are not provided). The scientific standard of the papers is high, but a reference text on sedimentary sulphur geochemistry most certainly it is not. However, workers in this field should find this book satisfying and useful.

H. Elderfield

VAN COUVERING, J. A. (ed.) 1997. *The Pleistocene Boundary and the Beginning of the Quaternary.* World and Regional Geology Series no. 9. Final report of IGCP project 41. xxi + 296 pp. Cambridge, New York, Port Chester, Melbourne, Sydney: Cambridge University Press. Price £80.00, US $120.00 (hard covers). ISBN 0 521 34115 9.

Funny things, boundaries; they have preoccupied stratigraphers since the subject began and still take a disproportionate amount of workers' attention. One need look no further than the classic Cambrian/Silurian contretemps between Sedgwick and Murchison. Yet almost every system still has at least one boundary which is controversial provoking hours of discussion, if not years of debate. Part of the problem of course, is that system boundaries are not just about geology but national pride, individual researchers' reputations and so on. The Pliocene–Pleistocene, or if you prefer the Tertiary (Neogene)–Quaternary boundary, is a typical example. It was realized a long time ago that the Pleistocene (Quaternary) was longer than the period represented by glacial events in temperate regions, such as the Alps or northern Central Europe. It became necessary therefore to demark the precise boundary between the glacial epoch and the non-glacial period preceding it; a not unreasonable desire. Because the Pleistocene is in most people's minds synonymous with the 'Ice Age', the most sensible approach seemed to be to establish the boundary at the first sign of refrigeration. The need to define the boundary in a 'continuous' marine sequence, following stratigraphical convention, led to a search for a suitable locality. The site selected in Calabria, southern Italy had appropriate sediments that were both accessible and included a climatic transition marked by the arrival of so-called 'cold guests' in the Mediterranean, in particular the mollusc *Cyprina (Arctica) islandica.* This boundary was accepted at the XVIII International Geological Congress in London in 1948 and has stood ever since.

Several sites in the area had been proposed for the stratotype but for various reasons it became necessary to select the most suitable sequence. Thus in 1974 a working group (IGCP-41) was established, under the International Geological Correlation Program, to define the boundary and to correlate it worldwide. The site chosen was called Vrica, the boundary stratotype being ratified and adopted as a GSSP. This book reports the work of the IGCP-41 group, under the leadership of Dr van Couvering and is, in effect, the group's final report.

The volume of edited papers begins with two introductory chapters that provide the historical background to the work. The first, by van Couvering, explains the foundations of the project, the historical concepts behind the boundary selection, the definition of the boundary at 'just below the upper limit of the Olduvai subchron' (i.e. 1.8 Ma), global correlation of the boundary and the arguments for lowering the boundary to 2.5 Ma (favoured by this reviewer) or otherwise. The second introductory chapter is a foreword by Nikiforova in which she lays out the terminological problems inherent in the global correlation of the boundary, particularly on the Eurasian continent.

The remainder of the book is divided into Parts in which individual papers are grouped in common themes. Part I describes the work of the IGCP-41 project workgroup. Part II contains five descriptive papers concerned with characterizing the details of the sediments and palaeontology of the Vrica section. This is indeed an interesting contribution, providing as it does the evidence for the lithological and palaeontological changes at the boundary all in one volume. Part III begins the task of correlating the boundary beyond the type locality by reviewing the evidence in deep-sea sediments, floral changes, mammalian faunal changes and human evolution over the Plio-Pleistocene boundary period. The final Part IV continues the task in a series of papers that attempt to identify the boundary in regional sequences in Italy, Israel, Iberia, France, England and Iceland, The Netherlands, west and east Germany, Hungary, Romania, the ex-Soviet Union, India, Japan, China, sub-Saharan Africa, Indonesia, New Zealand and North America. The book is completed by an index.

There is no doubt that this volume is useful, bringing together at it does 32 papers on this important period of time (0.5–4 Ma). The papers themselves are interesting, most are important contributions but all contain stimulating discussion and valuable evidence. That by Berggren & Burckle on deep-sea sediments is particularly thought-provoking, pointing out for example that the boundary selected occurs not as might be expected at a major climatic change but 'in the cold-climate maximum of Oxygen Isotope Stage 64'. Indeed this paper, possibly with the support of several others such as those by Grichuk, Zagwijn and Azzaroli *et al.*, sow the seeds of dissent from the boundary advocated here.

As a confessed dissenter myself, I was looking to be convinced that the Vrica boundary was a workable horizon: yet the more I look at the evidence presented, the more I feel that it is not very appropriate. Without ranging off into detailed arguments, one can simply say that the boundary drawn as it is at a lithological change is perhaps not ideal and there must be some doubt whether the few changes that actually occur at the boundary result from environmental rather than evolutionary events. The boundary sediments are even difficult to trace in the local region, let alone beyond. Few organisms actually appear or disappear permanently precisely at this boundary. Moreover, the climatic changes recorded differ little in magnitude or duration before or after the level selected.

One could be forgiven, therefore, for feeling that the Vrica boundary is not the best. As Berggren & Burckle and other less convicted authors point out, the first true climatic deterioration of glacial proportions in fact occurs much earlier at 2.4–2.5 Ma, the Pliocene–Pleistocene boundary long advocated by the Dutch in the North Sea region. This boundary is highly suited to international correlation because it is accompanied by numerous floral and faunal changes worldwide, it is followed by the earliest ice-rafting in oceanic sediments (Oxygen Isotope Stage 100) and it is virtually coeval with the Gauss–Matuyama magnetic Epoch boundary (2.6 Ma), as the editor notes in the preface.

Clearly then I was not convinced by the arguments proposed here repeatedly and at length for retention of this not very workable boundary. Whether or not you accept the Vrica section boundary is your choice, but this does not devalue the book as a source of much interesting evidence in summary form that is unavailable elsewhere.

What does reduce its value to some extent is that some of the information is out-of-date. This is because the book was intended to be published in the mid-1980s but preparation of some chapters was very slow, as the editor admits. Whilst anyone who has edited a book will understand and sympathize with his problem, I am afraid that the ten-year delay shows, even though most papers have been updated. Moreover, renewed discussions are now in progress, initiated this time by the INQUA Commission on Stratigraphy at the 1995 Berlin INQUA Congress, to reconsider moving the Pliocene–Pleistocene boundary to the 2.5 Ma position. These discussions may well make this collection age prematurely.

These considerations might reduce sales of what is after all an expensive, albeit well produced, book. If so, it will be a pity. This is because the amount of work presented here is impressive by any standard. I fear, however, that only libraries will choose to buy it. Whatever the judgement of the new debates, this book serves to illustrate the very real problems potentially awaiting those who attempt to hammer home their 'golden spike' boundaries in high-resolution geological successions.

Ph. L. Gibbard

FIOCCO, G., FUÀ, D. & VISCONTI, G. (eds) 1996. *The Mount Pinatubo Eruption. Effects on the Atmosphere and Climate.* NATO ASI Series I: Global Environmental Change, Volume 42. viii + 310 pp. Berlin, Heidelberg, New York: Springer-Verlag. Price DM 180.00, Ös 1314.00, SFr 157.00 (hard covers). ISBN 3 540 61281 5.

The eruption of Mount Pinatubo in the Philippines in 1991 was one of the largest and most damaging volcanic eruptions of the past two centuries. The eruption injected about ten cubic kilometres of pumice and ash into the atmosphere, along with 20 million tons of sulphurous gases. Human impacts aside (and there are some success stories to tell there), this unplanned experiment on the response of the climate system to a large volcanic perturbation provided an important opportunity to assess models which had last been properly tested in the aftermath of the 1982 eruption of El Chichon in Mexico.

This volume presents a broad spectrum of studies on the short-term climatic and atmospheric effects of the eruption, which were originally presented at a NATO advanced research workshop in Italy in late 1994. A total of 22 generally brief subchapters by 81 authors are grouped into four sections. In turn, these cover the characterization of the volcanic aerosol; the unravelling of the effects of volcanic eruptions on global surface temperatures; the observed and modelled effects of the volcanic eruption on stratospheric ozone levels; and the consequent global climatic impacts of the eruption. The volume includes both brief technical papers as well as a handful of longer and more discursive contributions. The longest both in terms of numbers of pages (40) and authors (31) stands out as a particularly useful investigation of the sensitivity of climate, and of models of the climate system, to volcanic eruptions. The production is adequate, with camera-ready papers produced in a variety of typefaces, but it includes some colour illustrations and a brief index.

The whole volume makes for a very detailed, but worthwhile, analysis of the effects of a major volcanic eruption on Earth's

atmospheric system. Some effects of eruptions are now really rather well understood: the behaviour of volcanic sulphur, once it is injected into the stratosphere, for example. Pinatubo provided some surprises as well, including the details of the effects of the eruption on stratospheric ozone. Observations following Pinatubo have clearly shown the importance of volcanic eruptions for the destruction of stratospheric ozone. The details are instructive – with increases in stratospheric ozone in the weeks immediately following an eruption due to oxidation of volcanic sulphur dioxide, and increases high in the stratosphere (in contrast to the depletions at lower altitudes), because of the removal of nitrous oxides by the volcanic aerosol. Other important results that emerge relate to the way that global surface temperatures are modified by eruptions. To a first order, global surface temperature changes are fairly readily detectable following an eruption of the scale of Pinatubo, but the magnitudes of the changes are not as large as might be predicted from a simple consideration of Earth's energy balance. In fact, patterns of warming and cooling and their regional distributions are important factors that will allow for more rigorous testing of more advanced global circulation models that allow for feedbacks within the ocean–atmosphere system.

Another lesson is that simple extrapolation of pre-Pinatubo models to predict the effects of the Pinatubo eruption would have missed many of the details. Extrapolation of the same models to some of the great eruptions of the past may also be far from straightforward, and it may yet be that some of the more lurid speculations on the global effects of the largest eruptions of yesteryear owe more to the human instinct of making a catastrophe out of a crisis and rather less to the complex ways in which nature responds to rare and dramatic events.

David Pyle

CAMPBELL, J. B. 1997. *Introduction to Remote Sensing*, 2nd ed. xxix + 622 pp. London, Bristol (PA): Taylor & Francis. Price £19.95 (paperback). ISBN 0 7484 0663 8.

Just as ever more capable remote sensing satellites are launched into now crowded orbits each year, so new introductory texts on the subject squeeze in amongst their predecessors on the bookshop shelves. Most of these books are well written and fairly comprehensive, and the differences between them are increasingly subtle. Covering remote sensing basics and some key aspects of digital image processing, Campbell's second edition falls into the category of a solid, no-nonsense book for newcomers to the discipline. With plenty of material on current remote sensing instruments, and on valuable WorldWideWeb resources, it is undoubtedly one of the most up-to-date texts currently available.

Campbell opens with a brief history of remote sensing followed by a chapter on electromagnetic radiation, then moves on to the first of three main sections: 'Image acquisition', 'Analysis', and 'Applications'. Part 1, 'Image acquisition', examines in detail a range of remote sensing techniques, beginning with photography. In addition to sections on familiar instruments such as Landsat and SPOT, there is a good chapter on imaging radar systems which outlines principles and key spaceborne instruments. Part 2, 'Analysis', briefly introduces topics such as geometric rectification and atmospheric correction before dealing in a more substantial way with image classification. A chapter on hyperspectral remote sensing finds its way in here, too. The final part covers a range of applications including vegetation studies and land cover mapping. Earth sciences applications are reviewed – though not to an extent that would be of much use to someone specifically interested in geological remote sensing – and there are some concluding pages concerning NASA's forthcoming Earth Observing System and Mission to Planet Earth.

Campbell's writing style is direct and concise. He is rigorous without recourse to mathematical detail. Although the clarity of line figures is good, of the relatively few satellite images reproduced, some are almost too cramped to provide much useful information. This includes some of the figures shown amongst seven pages of colour plates. The text is well referenced and indexed, and review questions are given at the end of each chapter. In terms of content, there are few surprises in this book but, so long as you're not looking for detailed expositions of the physics of remote sensing, this is certainly one of the best general introductions to the subject published.

Clive Oppenheimer

JACKSON, J. B. C., BUDD, A. F. & COATES, A. G. (eds) 1996. *Evolution and Environment in Tropical America*. ix + 425 pp. Chicago, London: University of Chicago Press. Price US $75.00, £59.95 (hard covers); US $27.50, £21.95 (paperback). ISBN 0 226 38942 1; 0 226 38944 8 (pb).

The gradual emergence of the Central American Isthmus was an event which initiated profound global change. Not only did its appearance separate the tropical American ocean into what are now two very distinct biogeographic realms either side of the barrier – the Caribbean and the Eastern Pacific – it also diverted global oceanic circulation, intensified the Gulf Stream, and eventually triggered the Northern Hemisphere glaciation. Further intensification of glaciation is probably responsible for an extraordinary burst of extinction and speciation about two million years ago which laid the foundations for the biotas we see today.

The coastal areas of the Eastern Pacific suffer local upwelling, more marked seasonality and higher tides than the Caribbean, as well as the periodic ravages of the ENSO climatic anomaly. As a consequence, primary productivity is higher, coral reef development is patchy, and predation pressure is more intense, in the Eastern Pacific. The formation and isolation of these two very different tropical seas combined with major environmental changes resulted in the evolutionary diversification of marine species either side of the Isthmus, as well as the joining of terrestrial biotas. But while the great interchange of terrestrial animals and plants has received detailed scrutiny ever since Darwin's *Voyage of the Beagle*, the shallow marine record has been largely ignored. Not surprisingly then, the exact magnitude and chronology of these dramatic events remains poorly known. This volume present the first synthesis of our current understanding.

This multi-author book grew out of a session at the Fifth North American Paleontological Convention, held in Chicago in 1992. It is the work of the Panama Palaeontology Project (PPP), and is edited by three founder members of the group. These researchers have set out painstakingly to construct a detailed stratigraphic framework and to gather a vast collection of fossils for the entire region. Data is now being assembled on a massive scale to reconstruct the biological, environmental, and evolutionary history of Tropical American seas.

In addition to a very useful Introduction and Overview, five chapters describe the geological and environmental effects of the emergence of the Central American Isthmus, and a further four concern the detailed record of particular groups (corals, arborescent cheilostome bryozoans, strombinid gastropods, molluscs). One chapter describes the phenomenon of transisthmian species

pairs, and two detail the terrestrial record (evolution of the tropical mammal fauna and Quaternary neotropical forest diversity).

One of the major themes to emerge from this impressive compilation of data and analysis is that the same environmental change can have numerous biological effects, which are often determined by the ecology of the organisms involved. It is also now apparent that the historical sequence of events can greatly influence the nature of biological change, but details as to how this actually happens are still far from clear. But all currently described patterns of diversification (snapping shrimps, corals, cardiid bivalves, strombinid gastropods) are gradual, and were probably influenced by increasing habitat complexity associated with the formation of the isthmus, not just by straightforward division of the oceans as was previously assumed. But if most modern species originated during these major upheavals, whatever is happening now in our seas may well shed no light on what actually occurs during speciation events.

This is the first attempt I know of to dissect the detailed history of an area by the integration of geological, palaeontological and biological information. Although major problems remain – the precision of regional stratigraphic correlation is still only about 1 m.y.; many groups are not yet sufficiently well sampled (for example, the editors suggest a minimum of 50,000 specimens will be necessary reliably to estimate the diversity of molluscan subgeneric, and 100,000 for species diversity, for any one time interval); and there is still very relative abundance data – it still represents a very impressive achievement indeed.

I wholly recommend this inexpensive book to all geological libraries and indeed to all research palaeontologists, not only as a model of collaborative research but also as a real attempt to discover the key to diversity and structure of biological communities. I also feel a great sense of optimism in their approach: we can look forward to great things from this group in the future.

Rachel Wood

LITHERLAND, M., ASPDEN, J. A. & JEMIELITA, R. A. 1994. *The Metamorphic Belts of Ecuador.* Overseas Memoir no. 11. x + 147 pp. + maps in folder. Keyworth: British Geological Survey. Price £65.00 (paperback). ISBN 0 85272 239 7.

Although the Ecuadorian image inevitably conjured up is the romantic one of snow-capped Andean volcanoes rising astride the Equator ('Chimborazo, Cotopaxi…'), the main cordilleras running north-northeasterly on either side of Quito are in fact comprised of a seemingly 'un-Andean' array of metamorphic terranes ranging in age from Precambrian to Cretaceous and comparable in complexity if not in the extent to the more celebrated suspect terranes of the western North American continent. This memoir, the product of a seven-year bilateral co-operation project between Ecuador and the UK, describes the field distribution, lithology, chemistry and metallogeny of the metamorphic and igneous rocks of the eastern Cordillera or Cordillera Real, and also the smaller, trans-Andean ophiolitic El Oro complex in the southwest of the country.

Extraordinary amongst the variety of metamorphics described are the extensive 'skarnfields' of metasomatized metasedimentary and metavolcanic rocks which form subhorizontal sheets some 200–300 metres thick, extending for 100 km or more along the Cordilleran watershed. These are interpreted as the remnants of great klippen thrust over from the west and sequentially 'skarnified' as they passed over the elongated ovens of the Azafian batholith. New concepts spawn new names, not always euphonious: 'skarnfield' has a nice Nordic ring to it, but '*skarnified*'? Such Jurassic skarnfields host much of the economic gold production of Ecuador, including the Nambija deposit which was worked by the Incas in pre-colonial times and has been the focus of a modern gold-rush since its rediscovery in 1982. Other more familiar metallogenic types of the Pacific Rim are not neglected, and the two 1:500 000 maps in the rear pocket include metal localities as well as the general geology of the described regions. The abundance of colour photographs illustrate the variety of rocks and give a hint of the arduous conditions of fieldwork in these elevated and hardly accessible terrains. An attractively produced and informative account for the armchair traveller as well as for the few who are actually likely to do fieldwork there.

G. A. Chinner

CRACKNELL, A. P. 1997. *The Advanced Very High Resolution Radiometer (AVHRR).* xi + 534 pp. London, Bristol (PA): Taylor & Francis. Price £60.00 (hard covers). ISBN 0 7484 0209 8.

The Advanced Very High Resolution Radiometer (AVHRR) is very much one of the work-horses of satellite remote sensing. It is a multichannel visible and infrared imaging system which has been installed on several spacecraft operated by the US National Oceanographic and Atmospheric Administration since 1978. Although designed with meteorological applications in mind, the reasonably high spatial resolution (around 1 km), frequent coverage, and available spectral channels were attractive to researchers in diverse fields including agriculture, terrestrial and marine ecology, climatology and volcanology, to name a few. As importantly, the data provide the global coverage and temporal continuity (AVHRR instruments have been in operation without disruption since 1978) essential to many kinds of climate and environmental change studies, and are more or less freely available (now via the Internet). In writing the first book devoted to such an important scientific instrument, Cracknell has skilfully identified and filled a significant gap in the remote sensing literature.

The first two chapters detail characteristics of the NOAA spacecraft, the evolution, construction and performance of AVHRR instruments, and the reception, format and calibration of their datastream from raw digital counts into physically-meaningful units of spectral radiance (essential for many quantitative applications). The next chapter covers the geometric processing of AVHRR images required to provide map-like products, and introduces cloud-masking and atmospheric corrections. Chapter 4 examines the measurement of Earth surface temperatures utilizing the AVHRR's thermal infrared bands – global sea surface temperature maps represent one of the key products of AVHRR data. One of the most serendipitous and widely practised uses of AVHRR imagery, however, is the analysis of vegetation type and phenology. This has come about because of the fortunate provision of red and near-infrared spectral channels, which show a strong differential response according roughly to chlorophyll abundance. A substantial chapter 5 investigates the derivation and interpretation of vegetation indices from AVHRR images, and looks at how these are used for, among other things, crop forecasting and fire risk assessment. The remainder of the book reviews other geophysical and atmospheric and environmental science applications of AVHRR data. Some of the more geologically-oriented uses include detection and surveillance of lava flows and ash clouds, investigations of pre-seismic soil temperature anomalies, and mapping of post-glacial landscapes.

Arthur Cracknell is Carnegie Chair of Physics at Dundee

University, and writes with great authority on the AVHRR. The university hosts the NERC-supported AVHRR data receiving station, and Cracknell has been deeply involved for over a decade in developing processing techniques and applications for the AVHRR datastream, and in teaching remote sensing to graduate students. He succinctly and elegantly summarizes the nuts and bolts of the AVHRR, its datasets, and their interpretation and applications. From Cracknell's enthusiasm for the instrument we quickly appreciate the ingenuity of researchers from diverse disciplines whose work has resulted in an extraordinary range of applications for what is, by today's standards, a quite unpretentious remote sensing tool. Despite its comparative lack of sophistication, the AVHRR goes from strength to strength – its future is secure with scheduled platforms to carry it into polar orbit beyond 2000. Cracknell's eminent book pays tribute to the AVHRR's outstanding success and will be of considerable importance to remote sensing students and researchers into the next millennium.

Clive Oppenheimer

MANN, S. (ed.) 1996. *Biomimetic Materials Chemistry*. xvi + 383 pp. New York, Weinheim, Cambridge: VCH Publishers. Price DM 189.00 (hard covers). ISBN 1 56081 669 4.

One of the first things a palaeontologist (or biologist) learns never to use is the word 'design': the wrath of an anti-teleologist is a sight to behold. But when one looks again at the sophistication, integration, and engineering of living organisms, then it is indeed difficult not to refer to design. Maybe by natural selection, but still breath-taking. While our admiration is chiefly taken by the intricacies of biochemistry and the fluidity of grace in moving animals, the construction of skeletons as biominerals is also little short of remarkable. Despite shells being regarded as common-place, and for long the trademark of taxonomist and geometrician, biominerals are now rapidly becoming a focus of human technology and it is not difficult to see why. Most are constructed from readily available elements, and not only are the skeletons synthesized at room temperatures but without the range of toxic by-products that characterize many existing human technologies. Biomineralization also exceeds our present abilities in terms of the scales of operation which are indeed impressive, operating as they do from precisely arrayed macromolecular assemblages to sculptured end-product. In a society which has seen the invention of micro-chips, liquid crystals and carbon fibres, it is little wonder that the opportunities for biomimesis are now being actively explored.

This book, edited by one of the world leaders in the field, is a survey of present trends and future possibilities. The potential range of applications is extraordinary. Perhaps the most fertile possibilities are those of thin films which either mimic or are derived from bacterial cell-walls and upon which compounds, perhaps with novel properties, can be seeded. There are also three-dimensional possibilities whereby structures similar to the protein family of ferritins could be used to encapsulate other compounds, such as drugs to treat illnesses that demand a precise delivery system to the affected area. But while the possibilities are enormous, so too are the difficulties. Thus, while the basic steps in synthesis of biominerals are fairly clear, even the details of mineral precipitation let alone macroscopic expression are still largely enigmatic. As one chapter notes in a review of the seemingly humble hen's egg, both the variable solubility of apparently identical crystals on the shell interior and the anisotropic porosity are very difficult, if not impossible, to obtain by conventional artefactual means. In terms of prostheses, such as an artificial bone, it may well be that a synthesis that closely tracks the method that occurs inside living vertebrates is the best course of action, but in many other cases the link between biomineralization and desired product is likely to be much more tenuous with Nature providing guidance rather than instruction.

For a geologist or palaeontologist, this volume provides a useful set of insights in a fast-moving field. It should also do much to encourage links between biology and materials science, although in the light of the current advances in genetic engineering it remains to be seen whether some of the apparent promise in the context of surface chemistries ever actually materializes. The challenges in the study of biomimetics remain immense, and I suspect that the more we learn about how a shell is built the more awe-struck we will be by not only the elegance of its design but the difficulties of emulation rather than imitation.

S. Conway Morris

WATT, I. M. 1997. *The Principles and Practice of Electron Microscopy*, 2nd ed. xi + 484 pp. Cambridge, New York, Port Chester, Melbourne, Sydney: Cambridge University Press. Price £80.00, US $110.00 (hard covers), £29.95, US $44.95 (paperback). ISBN 0 521 43456 4; 0 521 43591 9 (pb).

This is the second edition of Ian Watt's book, the first edition of which appeared in 1985. There have been many advances in the field since then, not least in computerization and automation, and consequently the book has expanded by over one third in order to do justice to them. There are three more chapters than in the first edition: on microanalysis, electron-beam interactions, and specimen preparation has its own chapter, now separated from the interpretation of images. Each chapter is concluded by suggestions for further reading and there are four Appendices for those who want to know more about vacuum systems, the production of thin films, how the wavelength- and energy-dispersive spectrometers work and the various types of electron source that are available.

The author's aim, as stated in the preface to the first edition, is to give an easily understood survey of the broad field of electron microscopy and its application in materials science, physics, geology and biology. It is a very readable book aimed at the novice with limited mathematical background, but it will also be useful to practitioners in one branch of electron microscopy who would like to know what other instruments and techniques can offer.

Chapter 1 lays the foundations by comparing and contrasting microscopy with light and electrons. It includes descriptions of the various aberrations and distortions that occur during imaging and how they are corrected. Chapter 2 is the new one on electron–specimen interactions. In describing the various signals that are produced, Watt gives a brief description of the detectors used and introduces the reader to the information that each signal can provide about the sample. However, I found the sections on crystalline structures and diffraction somewhat brief and not entirely accurate (use of the terms *form* and *habit* rather than *Bravais lattice*, for example).

The family of electron microscopes is described in Chapter 3. It is bang up-to-date, with new sections on the energy-filtering microscope, the environmental scanning electron microscope and the analytical transmission electron microscope. Here also is a discussion of the new forms of image recording: digital image plates and electronic (digital) imaging.

Specimen preparation for both SEM and TEM is the subject of the next chapter. However the coverage is unfortunately

incomplete as far as geological samples are concerned. There is no mention of the need to polish samples for back-scattered SEM and quantitative X-ray microanalysis and the treatment of ion- (or atom-) thinning is cursory. The statement that a glancing angle of 45–90° gives the maximum thinning rate is wrong; the optimum angle is about 30°. I am also puzzled by the statement that the wedge angle produced is twice the angle of thinning.

Chapter 5 is concerned with the interpretation and analysis of micrographs. There are 15 pages on TEM images, of which only two are devoted to the large and important subject of diffraction contrast, and 57 pages on SEM images, including stereoscopic microscopy. The chapter on analysis that follows is comprehensive in that it covers electron diffraction, X-ray microanalysis, electron energy-loss spectroscopy, auger electron spectroscopy and cathodoluminescence. The major omission here is a description of the origin, appearance and use of Kikuchi lines; after all, if you put a crystalline sample in the TEM, you cannot avoid seeing them!

The penultimate chapter covers 'specialized' techniques in the TEM and SEM, such as dark-field imaging and EBIC (electron-beam induced current), and other forms of microscopy and analytical techniques, such as field-ion microscopy, scanning-tunnelling and atomic-force microscopy, ion-probe analysis and X-ray diffraction.

The final chapter is entitled 'Examples of the use of electron microscopy'. It begins with a general summary of the types of problems that can be tackled by TEM or SEM and there then follow 15 case studies. These are immensely useful to the novice, particularly someone in an applications laboratory in industry, as they set out the problem and the results in an accessible way with excellent accompanying micrographs. Unfortunately only two of the case studies are geological: a study of the structure of opal and the identification of microfossils.

The text is easy to follow, the diagrams are simple, informative and clear, and the photographs are of high quality. I found few typographical errors, but some text appears to have been left out at the beginning of the section on focusing on page 197. Although I would strongly recommend this book as an introduction to a geologist who knows little or nothing about electron microscopy, he/she would fairly soon have to progress to another text, particularly if he/she was interested in TEM of crystalline materials or electron microprobe analysis.

P. E. Champness

FISHER, R. V., HEIKEN, G. & HULEN, J. B. 1997. *Volcanoes. Crucibles of Change*. xv + 317 pp. Princeton: Princeton University Press. Price £25.00, US $35.00 (hard covers). ISBN 0 691 01213 X.

Volcanoes have stirred the imaginations of people in many cultures; through their effects they have changed the lives of millions and through their products have stimulated and sustained economic and agricultural activity where otherwise there should be none. In this delightful book, Fisher and colleagues tell some of the many tales of volcanoes and their manifold influences on nature and humankind. The wide scope of this book is delicately balanced, being broken into four more or less coherent sections which in turn are divided into fifteen pithy chapters. From a vivid perspective of the unravelling of a volcanic tragedy (the eruption of Mount St Helens in May 1980), and a brief grounding in what volcanoes are and what they do, the reader is led on an enthralling tour of the risks (from death to destruction) and benefits (from concrete to viniculture) of volcanoes to humanity. This is a book to read: impeccably illustrated, it written with a light touch and in an engaging manner. Throughout, it is liberally illuminated by historical asides, literary and mythological references, and modern anecdotes. As an example of modern non-technical writing on volcanoes, which will be of interest both to scholars and to a much wider audience, *Volcanoes: Crucibles of Change* is without parallel. Dedicated, as it is, to colleagues who have died over past decades as a result of volcanic eruptions, this will make a fitting and long-lasting tribute.

David Pyle