
The origins of this 'mammoth' tome go back to 1974 when IGCP Project Ecostratigraphy number 53 was launched in Birmingham, England. That project in turn grew out of the lengthy deliberations of the Siluro-Devonian Boundary Subcommission in 1960s and the problems which had arisen in trying to define the boundary and select a boundary stratotype. Project Ecostratigraphy owed much to the growing convictions of two palaeontologists, Anders Martinsson (University of Uppsala, Sweden) and Art Boucot (University of Oregon, USA), who had worked together on the Boundary Subcommission, that the time was ripe for a more formal integration of biology, palaeontology and biostratigraphy. With some 140 years of study since the formulation of the Silurian System by Murchison, countless geologists worldwide had accumulated a vast amount of information about the sediments and fossil biotas of this age. But still there were significant problems in using the fossils to correlate between what were considered to be coeval deposits.

Although it has been known for a long time that the distribution of fossils within the stratigraphic rock record is generally reflected in complex patterning, every now and again hopes are raised that some straightforward underlying cause can be discerned that will make life easier for biostratigraphers.

Between 1911 and 1918, the Danish marine biologist C. G. J. Petersen established his well-known theory of marine animal communities based on grab sampling and statistical analysis. His analysis had shown the repeated occurrence of particular assemblages of animals on the seabed with a small number of dominant species and a larger number of much less frequent associated species. Development of this work showed that many different factors (e.g. water depth, substrate type and topography) determined the composition and distribution of these benthic marine communities in the Baltic. In addition, since the food chains are short, there is very little interdependence between the members of these marine communities.

In the 1960s a series of Silurian fossil benthic marine 'communities' were described by Fred Ziegler (1965) which he claimed were depth-related and could be used to reconstruct palaeobathymetry across the shelf. He even attempted to define absolute depths of his brachiopod-dominated 'communities'. Because Ziegler's work suggested a fairly simple link between depth and 'community' composition it stimulated a new burst of research activity in Silurian palaeoecological and biostratigraphic studies. 'Grab' sampling and statistical analysis of sediments and their biotas produced a great deal of very useful work such as that by Watkins (1979).

Necessarily, as any marine biologist would have predicted, 'things' turned out to be more complex than Ziegler had envisaged. The focus on depth control was an oversimplification and it became clear that substrate and other factors played important roles. Arguments about the nature of the so-called fossil 'communities' and how they compare with living communities emerged and in turn stimulated useful taphonomic work on how groups of fossils are actually recruited to the sediment record.

Luckily all this effort coincided with the emergence of Art Boucot as an incredibly energetic and determined palaeontologist interested in Siluro-Devonian palaeoecology, biostratigraphy, evolution and brachiopods. Boucot has been a great 'shaker and mover' who developed an holistic approach to the whole question of 'palaeocommunities', their biofacies and evolution, which he calls 'ecostratigraphy'.

Paleocommunities represents a milestone in the development of the whole notion of ecostratigraphy and the hope that the development of ancient marine communities can be charted through space and time. Through Boucot's energy and persuasion over 50 papers on aspects of Siluro-Devonian fossil 'communities' from Novaya Zemlya to Sardinia have been contributed by a truly international group of experts. The compilation will be an invaluable reference for all those concerned with this particular phase in Earth history and those interested in the more general question of the potential and pitfalls of this type of palaeobiological analysis. The only downsides are the price and delay in production. A project of this size is like a massive wartime convoy of shops whose progress is determined by the slowest. Most of the references are at least ten years old now, some of the contributors have retired and at least one has died. Nevertheless, since this volume brings together such a diversity of information it will have a considerable shelf life.

Douglas Palmer

References


Since Smithson Tennant, in 1791, showed that diamonds were very nearly pure carbon, a new chemist's dream of turning coal or graphite into diamonds has driven scientists and charlatans in this quest. Robert Hazen, a leading researcher in high-pressure mineralogy and crystallography, has written a fascinating and very readable account of the history of the synthesis of diamond. He traces the early experiments of James Ballantyne Hannay and Henri Moissan, the Nobel-prize-winning chemist. They took their lives and those of their assistants in their hands in the quest to make diamonds; chemistry in the nineteenth century held many hazards. As Hazen points out, the early workers evidently failed to make diamonds but their research was neither flawed nor useless. All scientific progress is built on
the hard-won knowledge of previous generations and these scientists had taken the first steps in striving to achieve the pressure and temperatures that would accomplish this elusive Goal. In the twentieth century, Percy Bridgman of Harvard pioneered modern high-pressure research; although it appears that he never admitted to attempting diamond synthesis, it is clear that he too embarked on the quest. Baltzer von Platen, the inventor of the portable refrigerator, persuaded ASEa (a Swedish electricity company) to spend years and a huge sum of money on the search. They were in fact the first to synthesize diamond early in 1953, nearly two years before General Electric scientists achieved the same. But the Swedes, disappointed with their obviously non-commercial method, kept quiet about their discovery for a further seven years. The GE team achieved diamond synthesis in December 1954 and went on to develop what is today a huge industry. Hazen also explores recent advances in the chemical vapour deposition synthesis of diamond and in the application of diamonds in high-pressure research.

This is a very fine book, and the success of the book stems from the manner in which Hazen weaves the characters of the main researchers, be they noble, eccentric, highly ambitious or slightly crazy into the narrative. Hazen is a very fine writer and one hopes that this book receives the popular success it deserves and that he will continue to write similar books. Outstanding!

Allan Pring


This book arises from a Discussion Meeting held in 1996, and consists of thirteen papers, most of which were previously published in the Philosophical Transactions of the Royal Society. As is inevitable with such proceedings volumes, the book is a snapshot of a few specific areas of research rather than a comprehensive treatise. A significant omission is consideration of tectonic processes such as faulting and seismicity. The chapters may be divided into summaries of developments over the last decade or so (papers by White, Fouquet, Juniper, Jannasch), reports on more specific experimental or theoretical results (papers by Blackman, Sinha, Cormier, Butterfield, Mills and Speer), and more focused reviews which survey the foundations of a particular body of science and then move on to present some specific new contributions from the authors (papers by Kelemen, Asimow, Schultz); I find the last category the most useful.

The book begins with a numerical modelling study by Blackman & Kendall on the effects of olivine crystal alignment and melt retention on the pattern of P and S wave travel-time delays for teleseismic phases. Sinha et al. summarize the results of a seismic and electromagnetic experiment on the Reykjanes Ridge, which shows the first convincing geophysical evidence, outside Iceland, for a magma chamber at a slow-spreading ridge. In a carefully argued paper, Asimow et al. review thermodynamic models of isentropic melting of peridotites and present a new model in which melt production increases rapidly as pressure decreases. Kelemen et al. present a comprehensive review of the evidence for melt migration in the mantle beneath ridges, based on ridge geochemical data, numerical modelling, and field observations in ophiolites. White reviews the crustal effects of ridge-plume interaction in the North Atlantic. Cormier presents geophysical observations from the flanks of the southern East Pacific Rise which show that the axis has been very unstable over the past few million years.

The focus then switches to hydrothermal processes. Butterfield et al, investigate the evolution over time of vent fluid chemistry, focusing on the 1993 volcanic event at CoAxial seamount on the Juan de Fuca Ridge. Schultz & Elderfield review estimates of global heat and fluid flux from hydrothermal systems and their theoretical foundations, and then report and interpret tidal periodicities in vent fluid temperature and velocities at the TAG site on the Mid-Atlantic Ridge. Fouquet briefly reviews the tectonic settings of hydrothermal sulphide deposits in the oceans. Mills & Tivey study seawater entrainment in the TAG mound from the chemistry of anhydrite and of fluid inclusions within the anhydrite. Speer shows that a very large heat transfer is required for a water-column plume to penetrate the thermocline and interact with the atmosphere, and therefore that such events must be rare. Juniper & Tunnell discuss the influence of geological factors such as spreading rate, ridge age and eruption frequency on vent ecosystems. Finally, Jannasch briefly reviews chemosynthetic reactions at hydrothermal vents and the phylogeny of vent microbes.

The book has been carefully edited and I found little to criticize; one minor irritation is a number of references to papers ‘in press, 1997’, which I feel could have been updated. The book will form a valuable reference text for mid-ocean ridge researchers and some of the reviews will provide a useful starting point for graduate students or researchers moving into a new field.

T. A. Minshull


This is an introductory, interdisciplinary book about Earth interactions that uses James Lovelock’s Daisyworld to introduce important concepts from systems theory to explain the regulation of processes. The carbon cycle forms the basis for much of the book’s discussion of the interactions between the atmosphere, the oceans, the biota and the solid Earth, with the goal of being able to compare the present loss of biodiversity with mass extinctions that have occurred in the Earth’s past. In common with many Earth Science books at this level, it is aimed at nontechnical American undergraduates and is based on lectures given by the authors to their respective students. It is an issues-based book where the details of geology, ecology, climatology and oceanography are subsumed by unifying principles applied at a global scale. The underlying concepts of the global energy balance, plate tectonics, the chemical environment, recycling of elements and biodiversity are illustrated by the issues of global warming, ozone depletion, climatic change, human threats to biodiversity and planet stability. Throughout is the underlying theme that modern environmental problems have analogues from the geological past.

The layout of the book is student-friendly with key questions at the beginning of each chapter and key words in bold and listed at the end of each chapter. It has useful appendices (e.g. unit conversions and the periodic table) and an excellent glossary. Each chapter finishes with a summary, review questions and ‘critical-thinking problems’ aimed
at testing understanding and a bibliography divided into general and advanced sections so that interested students can take their knowledge further. Most diagrams and photographs are in black-and-white but there is a section of colour plates in the middle of the book. Non-mathematics students may find the number and use of equations daunting at first (e.g. the planetary energy balance in Chapter 3) but they are clearly laid out and explained; the more important ones are tested with questions at the end of the chapter.

The book is unlikely to fit directly into a British A-Level course but should add valuable insights for students following Geology, Biology, Geography and Environmental Science A-Level courses. It would also be a very good source book for information about Earth Science topics needed in General Studies A-Level courses. For maximum benefit, a good scientific and mathematical knowledge at GCSE level is needed as some of the concepts, diagrams and critical-thinking questions are quite challenging. This book would therefore make an excellent addition to college libraries for sixth formers and should be able to provide some ideas for teachers of all the A-Level courses mentioned above.

Bridget Oeppen


The study of rocks that have been metamorphosed at great depths in the Earth has always been one of the more glamorous branches of geology, and with it has gone the seemingly intractable problem of how to get such rocks back to the surface relatively quickly. Here is a collection of 16 papers devoted to this topic, arising from a conference on that theme. The papers are grouped according to three of the common settings in which high-pressure metamorphic rocks are found, namely subduction zones, continental mountain belts, and regions of extension (mostly continental). Rather surprisingly (to me, at least), the editors refer to the first two environments as B-type and A-type subduction, which revived nostalgic echoes of the early days of Plate Tectonics. Do people really use those terms now? (Obviously, yes, but I think it dates them.) The editors and contributors recognize three general processes that are likely to be important in bringing high-pressure rocks to the surface: erosion, faulting and some sort of ductile flow, and these are the contexts in which most of the papers discuss their observations. There is a lengthy review of 'exhumation processes' by the editors, and then 14 of the remaining 15 papers are essentially observational, describing structural and thermochronological data from many different parts of the world. The wide geographical spread of the contributions by some of the major players in the subject is one of the attractions of this volume for those who want to explore the literature on this topic.

There is general agreement that the ultra-high-pressure rocks from 100–125 km are associated with continental collision belts, whereas extensional terranes usually reveal rocks from more modest mid-crustal levels. Most authors manage to accommodate their observations into an exhumation model that appears to satisfy them, and they may or may not be right. The subject seems swamped with data, but what strikes me (an outsider) most about it is its apparent lack of support from a basic understanding of likely physical processes. Only one paper was theoretical, and that was a simple analysis of the density-driven movement of a rigid body through a viscous medium, but it was a breath of fresh air. The topic appears to be in serious need of heavyweight theoretical input. For example, people acknowledge that lower crustal flow occurs in some extensional terranes, but have little knowledge of what to look for or expect in terms of timing, duration, amplitude and wavelength of vertical motions. Until that occurs they are free to interpret their data as they like: it is a game with few rules, and unconvincing.

James Jackson


Sixty-five million years after the dinosaurs disappeared under tons of rubble, tsunamis, and uncontrollable forest fires, the science of geology was revitalized by the dramatic evidence for a bolide crashing into the Earth and so ending the Cretaceous with a bang. And so a new paradigm, it has been claimed, has been emerging. It is based on catastrophism, and makes reference not only to extra-terrestrial impacts, but also punctuated equilibria, chaos theory and even more radical suggestions such as sudden changes in the Earth's obliquity or catastrophic melting of ice sheets driving bewildered inhabitants inland and leaving garbled records of an immense Flood. The thoughts of once neglected workers, notably Schindewolf and Goldschmidt, are rescued from previous opprobrium, whilst the guardians of uniformitarianism and neo-Darwinism find themselves under increasing attack. The ideological stakes are raised, and those with a sound understanding of the Marxist tactics of spinning half-truths and demonization move into position. Science enters a ferment of controversy.

And this is what this rather long books tries to capture. The imagination of Trevor Palmer, a biochemist based at Nottingham Trent University, has clearly been seized by the new catastrophism. The scope and range of Palmer's reading is quite extraordinary, and as such Controversy provides a valuable launch pad into the literature. The ground covered is correspondingly broad and it is here that we encounter some difficulties. First, the text lacks a certain critical acumen. Material is reported, and indeed contrarian views are given, but the net result is more similar to an immensely long New Scientist article. It is the product of a fascinated onlooker rather than a critical participant. This is apparent, for example, with the discussion of those giant impacts. Palmer gives an up-to-date review of not only the K/T event, but also the myriad of other episodes registered by either an enormous crater or some signature from the ejecta, most famously iridium and shocked quartz. Yet it is a very curious fact that of these only the end-Cretaceous (K/T) impact can be unequivocally linked to an episode of massive extinction. To the impact enthusiast and catastrophist, as Palmer certainly is, this is not a problem. Of course other extinction events (and indeed evolutionary pulses) may yet transpire to be caused in the same way as the K/T event, yet again and again we see that either the timing of the event or the size of the resultant crater seem to be awry. And in some cases it is beyond dispute that, yes, a giant rock fell out of the sky, but
for all intents and purposes nothing happened to the biosphere. Also unremarked, and contrary to received opinion, it is arguable whether mass extinctions are as important in evolutionary process as is widely supposed. To be sure the extirpation of the dinosaurs seemingly opened the portals to the mammals, yet even in this event many other groups went through with little change. And in at least some mass extinctions, notably those at the end of the Ordovician, the late Devonian and end-Triassic, it is questionable just how profound the long-term effects really were. This is not to deny mass extinctions are important, clearly they are. But I am beginning to think that they are given more than their due, and it is probably mistaken to suppose that these catastrophic events are uniquely important in the driving of evolution. This contrarian view could go a long way to undermine the central thesis of this book.

Controversy is, therefore, a book that in some ways is unbalanced. This also comes across in the quite lengthy sections where Palmer takes to task various mavericks, or less politely pseudoscientists, and those warped geniuses who have blundered into areas where their understanding is lamentably deficient. There really seems little point in affording these peripheral figures a platform. In conclusion, Palmer has produced an intriguing book, rich in information and covering a broad sweep of catastrophic thought. It is isarguable whether mass extinctions are as important in the driving of evolution. Today, they outweigh the surface biomass. His is something of a minority outlook.

Simon Conway Morris


Some publicans are wise enough to post a notice behind the bar that bans discussion of religion or politics on the premises. Adding Thomas Gold's deep-Earth gas notion, the central thread running through The Deep Hot Biosphere, to the list would be a wise move for Earth scientists. That is, if adherents to his world-view were thick on the ground. A proselytiser leaps unchained from the text and, if his readers' comments on amazon.com are anything to go by, Gold is winning support among the laity as the architect of a 'paradigm shift'. The Deep Hot Biosphere ranks around 6000 on the list of all electronic book sales, although I learned to my amusement that many of his readers also bought the latest in J. K. Rowling's 'Harry Potter' series! Gold implicitly lays a trap for the unwary reviewer, by likening the general annoyance generated by his views to that directed at Alfred Wegener 80 years ago. He seems to seek the mantle of modern Earth science's misunderstood hero, indeed its Moses. Thomas Gold's notion that petroleum and even coal owe their origin to methane upwelling from a mantle reservoir is familiar to most Earth scientists. In The Deep Hot Biosphere Gold welds this view to the discovery in recent years of ever deeper occurrences of living thermophilic bacteria in boreholes. He builds a case not only for the deep biota's catalysing the deposition of petroleum and coals from primordial methane, but that they represent relics of life's origins in deep, crystalline, basement rocks, and that, even today, they outweigh the surface biomass. His is something of a minority outlook.

Gold writes well, persuasively and very successfully, as the standing of The Deep Hot Biosphere in the science best-seller list shows. Two or more decades ago Erich von Daniken held an even larger audience enthralled with works such as Chariots of the Gods. Von Daniken was an excellent communicator of his compilation of arcane facts taken out of scientific context and placed in one that he created metaphysically. Gold, however, does not wish to persuade us of supernatural or extraterrestrial forces. Instead, he bases his ideas on strong evidence that Earth accreted from volatile-rich presolar materials, exemplified by carbonaceous chondrite meteorites, among the most primitive materials in the Solar System. His view is that the Earth's mantle is still a vast repository of carbon in the reduced form of methane (CH₄), that continually wells up to the surface. Gold's riposte to those of us quite happy with a biogenic origin for what we term 'fossil fuels', is that we ignore evidence to the contrary. True enough, for many of the arcana that Gold assembles in support of his notions are generally sidelined by the mainstream of Earth scientists. Yet Gold is not even-handed either, as is his right in building a case. The central question is, however, not whether there are awkward and untidy bits of information that current ideas are always unable to encompass, but whether powerful evidence is omitted in building alternative ideas. In this review I examine a few of these and also Gold's understanding of others that he marshals to his cause.

Probably the most basic question to ask, in the context of whether or not the mantle is rich in hydrocarbons, is about the oxidation state of the mantle now and in the past. Reduced, volatile materials almost certainly did contribute highly to Earth's original mass, but did such matter survive in a reduced state? Volcanic emissions of nitrogen, and carbon– and sulphur–oxygen gases, rather than reduced compounds such as ammonia, methane and hydrogen sulphide, form powerful evidence for an oxidizing mantle, in the fundamental sense of the abundant presence of electron acceptors (not oxygen bound up in silicates, which is where Gold's mantle chemistry finishes). Diamond, on which Gold places considerable weight, likewise evidences primordial carbon's response to oxidizing conditions in the mantle, for the loss of hydrogen atoms by C–H compounds to form elemental carbon is itself oxidation.

How and when did the mantle acquire its oxidizing state? Whereas Gold spends considerable space on the Earth's accretion, one feature of the Earth's bulk geochemistry, which he does not mention, is its depletion in volatile compounds and elements relative to chondritic meteorites that were probably its predominant parental materials. This volatile depletion, held in common with lunar materials, together with the Moon's lack of a core and overall iron depletion, form the primary evidence in support of Moon formation from the Earth after a collision with a Mars-sized body before 4.45 Ga, the age of the lunar highland anorthosites. Such a hugely energetic event also explains formation of the lunar highland crust by flotation of feldspar from a deep magma ocean on the Moon shortly after its condensation from incandescent vapour. Not only is it highly likely that the surviving Earth had a similarly molten outer zone, but that is also a parsimonious mechanism for segregation of the bulk of its metallic iron, and the highly reducing potential that represented, into the core. The weight of evidence is that the Earth's mantle has been in an oxidizing state since that event. Survival of a vast reservoir of primor-
dial reduced C–H compounds in the mantle is therefore questionable to say the least.

The biological nub of Gold’s arguments is that life arose in the deep Earth, basing itself there on metabolism of upwelling methane. Isolated from the thermally destructive effects of the Hadean bolide flux, especially that of the Late Heavy Bombardment, it would thereby survive, to colonize the surface environment once impacts waned after 3.8 Ga. That seems plausible enough, but presumes that the earliest lifeforms were thermophilic methanotrophs. Whereas molecular studies suggest that the most primitive living things are thermophilic Archaea and Bacteria, evidence that helps mainstream biologists to suggest an origin for life around sea-floor hydrothermal vents, Gold is unable to cite evidence for the primitive nature of any modern thermophilic methanotrophs. To write, as he does on p. 168, that the most important advantage for a deep origin for life is ‘the abundance of energy upwelling from below’, and later that ‘On the surface, a large chemical energy supply would thus commence only ... after photosynthesis’, is absurd. The issue is not energy, but the formation and stability of the peptide bond from which much of the polymer-chemical architecture of life springs. Most specialists place greater emphasis on an abundance of water to mix litho- and hydrochemistry to provide the chemical appurtenances for a whole range of ‘experiments’ and chemo-autotrophic metabolisms. That needs space.

In an astonishing sleight of hand, Gold sets out to show that sufficient space is available in deep-crustal rocks for not only the origin of life there, but also a stupendous, though unseen, modern living biomass. This hinges on the average porosity of crystalline basement rocks. He assumes a value of 3% in order to arrive at an estimate for the deep, hot biosphere that matches his grandiloquence. Sadly, he has used the average for sedimentary rocks, whereas the porosity of crystalline rocks, even measured under surface conditions, is three orders of magnitude less.

Hydrothermal vents on the ocean floor do emit methane, and this might seem to support its origin from a reduced mantle source. Gold’s own emphasis on the presence of thermophilic Archaea in new oceanic lithosphere offers a ready explanation. Why should not thermophilic methanogens, abundant around hydrothermal ‘black smokers’, infest ocean crust soon after its formation in contact with sea water? Generation of hydrogen during serpentinization of ultramafic ocean lithosphere offers a ready energy source for such organisms and for their reduction of circulated CO₂ to methane. Well-known emissions of methane from continental crust are easily explained by burial and over-maturation of organic material in sediments: the majority view that Gold shuns.

Gold’s most provocative conjecture is that black coal is wholly abiotic in its origin, while lignites and peats are not. This he bases on obscure examples of intrusive veins of coal in a few tectonically disturbed fields, backed up with reference to non-existent body fossils in coal that are uncompressed and filled with coal. He proposes the wholesale carbon-metasomatism of sedimentary rocks, whereby methanotrophs oxidize methane to elemental carbon. Coals are often full of spores, spatially associated with mudstones bearing abundant plant-leaf remains and generally underlain by seafloors bioturbated by roots. Coal seams are separated in the most intricately repetitive manner by manifestly coal-free marine, brackish-water and terrestrial sediments, presumably eschewed for reasons of taste by his all-pervading methanotrophs. Moreover, only stratigraphic sequences with independent evidence for warm, humid terrestrial conditions are so endowed with black coals, and are separated by huge thicknesses not well known for coaliness. The same omission of simple facts characterizes Gold’s treatment of petroleum. He says that one oil occurrence is often underlain and overlain by others in reservoirs of different ages, yet omits to note that oil shales (source rocks to most of us) are stratigraphically restricted largely to global ocean-anoxia events that are probably linked to failures of ocean circulation. For Gold, fluids must migrate directly upwards, and heterogeneous hydraulic conductivity that underpins lateral migration is not to his liking.

I could go on, for I took perverse delight in reading The Deep Hot Biosphere. It will entertain all geologists immensely. Read his views about carbon isotopes, about helium, the uranium content of oil and coal (despite the fact that uranium has vanishingly low solubility in reducing fluids, Gold demands that it moves with methane) and about biogenetic magnetite (and puzzle why any magnetostratigraphy has been preserved). Search in vain for explanations about the left-handed chirality of molecules in kerogen, for how oxygen came to dominate the atmosphere and a runaway greenhouse effect was avoided. Finally, be amazed by ‘forces of unknown origin, held responsible for plate tectonics’ (p. 144). This is a collector’s piece.

S. A. Drury


Until recently the Manx Slates of the Isle of Man might fairly have been argued to be one of the very few remaining ‘frontier’ areas in the geology of the British Isles, largely neglected for almost 100 years save for one heroic single-handed effort about 35 years ago which predated the impact of plate tectonics and modern sedimentology. Scope for progress was thus huge and has been fully realised with this documentation of the results of focused multidisciplinary attack by collaborative teams in the period 1995–8.

After an editorial introduction and a very useful historical review of previous research, the book divides into six sections totalling twenty papers. ‘Stratigraphy and Lithofacies’ describes the graptolite/acratiarch fauna and the associated ichnofauna of a revised Manx Group, and provides formal definition and preferred correlations of agreed formations, with descriptions of other as yet informal units. ‘Sedimentation’ describes the facies and geochemistry of the turbidite sandstones of the Group and the occurrences of debris flows and manganese-rich horizons. ‘Magmatism’ discusses the geometry and tectonic affinities of the Poorstown Dolerite body. ‘Post Ordovician Units’ details the shattering discovery of the Wenlock age of the Niarbyl Formation, formerly included in the Manx Slates, and describes its sedimentology; concluding with palaeomagnetically-based accounts of the conglomerates of Siluro-Devonian and early Carboniferous age. ‘Tectonics and Metamorphism’ deals with large-scale structure suggested by geophysical studies, smaller-scale structure as seen in outcrop, and the evolution of cleavage fabrics in relation to burial and contact metamorphism. ‘Regional Comparisons’ places the Manx Group
and the Niarbyl Formation in the context of the Lower Palaeozoic geology of southeast Eire, the Lake District and the Southern Uplands. The book concludes with a near definitively full bibliography of Isle of Man geology.

The editing is refreshingly open about ongoing differences of interpretation but might have pounced harder on the considerable amounts of repetition between many of the papers. Somewhat disappointingly considering the title of the book, there is a curious reticence to speculate on the details of Palaeozoic plate geometry in the region beyond the simple cross-sectional cartoons given in the editorial introduction and, surprisingly, there is no mention of the Arenig geology of Anglesey and mainland North Wales in the otherwise excellent regional comparisons. No updates on the acid intrusions of Dhoon and Foxdale are included. Fold geometry description is plentiful on the small scale but regrettably lacking on that of the whole island, save for one set of alternative cross-sections in a lithofacies chapter. There is clearly much left to do, not least to resolve the conflicting interpretations of Manx Group palaeoevents, and it is one of the major strengths of the book that such needs are clearly evident. The importance of these papers for future research on the Isle of Man entirely justifies their issue as a book rather than within a journal thematic issue: full price is not unreasonable and the discounted price is splendid value. Production is to good standard with a full index although photographic quality is sometimes marginal.

It would be a shame if use of this breakthrough in knowledge were confined to researchers on the British Lower Palaeozoic, as it communicates well the general challenge (and perhaps a little of the excitement) of disentangling a Palaeozoic, as it communicates well the general challenge and is prepared to admit to the limits of knowledge and ages to do so without striking ‘holier than thou’ postures and is overtly bringing his understanding of the lessons of the fossil record to the present sociopolitical arena. He also manages to do so without striking ‘holier than thou’ postures and is prepared to admit to the limits of knowledge and understanding.

The question of what palaeontology can teach us about the future is one that most people interested in fossils are probably concerned with at some time or other. However, Niles Eldredge is one of the relatively few palaeontologists who overtly brings his understanding of the lessons of the fossil record into the present sociopolitical arena. He also manages to do so without striking ‘holier than thou’ postures and is prepared to admit to the limits of knowledge and understanding.

Life in the Balance is a plea to biological diversity and the need to retain as much of it as possible despite impending decimation by what Eldredge calls the Sixth Extinction. This is the most recent of life’s setbacks and the one which we are responsible for. We are eating ourselves out of house and home and despoiling our nest into the bargain. Our continuing ability artificially to improve a select number of grasses and ungulate mammals has grossly distorted the balance of life and diversity. As Eldredge says, ‘if we have arrived at this exalted/troubled state through our own cleverness, surely we are smart enough to call a halt, to say enough, to stabilize, to strike a balance’.

Whilst Eldredge’s ecologically based argument will be familiar enough to most scientists, he does put it over with considerable eloquence and persuasion and plenty of hard information in this book. Designed for the general reader and stylishly illustrated by Patricia Wynne, Life in the Balance would serve as good background reading for any students taking general palaeobiology courses. There are two very useful appendices, one listing animal species extinct since 1600 and the other listing some 400 lifeforms upon which we are dependent for our survival.

David James


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It would be a shame if use of this breakthrough in knowledge were confined to researchers on the British Lower Palaeozoic, as it communicates well the general challenge (and perhaps a little of the excitement) of disentangling a Palaeozoic, as it communicates well the general challenge and is prepared to admit to the limits of knowledge and ages to do so without striking ‘holier than thou’ postures and is overtly bringing his understanding of the lessons of the fossil record to the present sociopolitical arena. He also manages to do so without striking ‘holier than thou’ postures and is prepared to admit to the limits of knowledge and understanding.

The question of what palaeontology can teach us about the future is one that most people interested in fossils are probably concerned with at some time or other. However, Niles Eldredge is one of the relatively few palaeontologists who overtly brings his understanding of the lessons of the fossil record into the present sociopolitical arena. He also manages to do so without striking ‘holier than thou’ postures and is prepared to admit to the limits of knowledge and understanding.

Life in the Balance is a plea to biological diversity and the need to retain as much of it as possible despite impending decimation by what Eldredge calls the Sixth Extinction. This is the most recent of life’s setbacks and the one which we are responsible for. We are eating ourselves out of house and home and despoiling our nest into the bargain. Our continuing ability artificially to improve a select number of grasses and ungulate mammals has grossly distorted the balance of life and diversity. As Eldredge says, ‘if we have arrived at this exalted/troubled state through our own cleverness, surely we are smart enough to call a halt, to say enough, to stabilize, to strike a balance’.

Whilst Eldredge’s ecologically based argument will be familiar enough to most scientists, he does put it over with considerable eloquence and persuasion and plenty of hard information in this book. Designed for the general reader and stylishly illustrated by Patricia Wynne, Life in the Balance would serve as good background reading for any students taking general palaeobiology courses. There are two very useful appendices, one listing animal species extinct since 1600 and the other listing some 400 lifeforms upon which we are dependent for our survival.

David James


This is the tenth edition of an American manual of laboratory exercises first published in 1964 aimed at undergraduates specializing in geology; as such, its general format will be familiar to many. The objectives of the first edition are unchanged but the content is considerably updated and makes use of new technology such as satellite imagery and radar images, aerial photographs and computer-generated shaded relief maps. The focus of the book is on global dynamics and aims to generate understanding of how ‘change is the result of a simple system of the flow of energy’. There are a number of exercises new to this edition using the new technology outlined above to illustrate concepts associated with plate tectonics.

The exercises are grouped into sections (e.g. igneous rock) and are all introduced with a conceptual background and a list of key ideas. The layout of the book is easy to follow and the use of colour is excellent. Its main drawback for the British market is the dominance of the American illustrative material in the sections on topography, but the presentation of photographic and remotely-sensed material is so good that any interested British student should feel compelled to look through these sections and attempt the exercises aimed at their interpretation. The sections on rocks and minerals are also supported by good colour photographs and summary tables, and will assist practical identification exercises for A-Level Geology students. However, much of this material is available in other books and therefore it is not worth purchasing this book for that alone. For an A-Level student, the colour-enhanced satellite imagery and the images of different parts of the ocean floor cannot fail to increase interest and motivation. The exercises may give teachers some ideas for questions using their own resources; many of the exercises involve writing on the illustrative material in the book and therefore it is unlikely that schools and colleges would provide this as a textbook. Nevertheless, it would make an excellent present for an A-Level student and would certainly be a useful addition to the reference section of a college library.

Bridget Oeppen