non-marine. According to Lucas, Cassinis & Schneider in their introduction, even historic stratigraphic terms such as Rotliegend, Zechstein, Autunian, Saxonian and Thuringian are inadequately defined.

But as the 14 essays in this volume show, there has been considerable effort in recent decades to see how the Permian non-marine sequences can be integrated into the formal definition of the Permian SGCS. The biostratigraphic potential of fossil groups such as the freshwater conchostracans, ostracodes, insects and bivalves has improved significantly. Additionally, there has been a lot of interest in the vertebrate palaeontology with attempts to integrate body and trace fossils. But there is still a long way to go in the correlation of non-marine biostratigraphy with the expanding magnetostratigraphic and radio-isotope data. Nevertheless, this volume is an extremely useful update on non-marine Permian biostratigraphy and biochronology, and will be of interest to a wide range of interest groups from a broad spectrum of palaeontologists to stratigraphers.

Douglas Palmer

DAVIES, J. R., SHEPPARD, T. H., WATERS, R. A. & WILSON, D. 2006. *Geology of the Llangranog District – a brief explanation of the geological map*. Sheet Explanation of the British Geological Survey, 1:50 000 Sheet 194 Llangranog (England and Wales). ii + 38 pp. Keyworth: British Geological Survey. Price £9.00 (paperback); including map £18.00. ISBN 978 0852 72566 5.

BRITISH GEOLOGICAL SURVEY. 2006. *Llangranog. England and Wales Sheet 194. Bedrock and Superficial Deposits. 1:50 000*. Keyworth: British Geological Survey. Price £12 (folded and cased); including Sheet Explanation £18.00. ISBN 0 7518 3447 5 (flat); 0 7518 3448 3 (folded and cased).

DAVIES, J. R., SCHOFIELD, D. I., SHEPPARD, T. H., WATERS, R. A., WILLIAMS, M. & WILSON, D. 2006. *Geology of the Lampeter District – a brief explanation of the geological map*. Sheet Explanation of the British Geological Survey, 1:50 000 Sheet 195 Lampeter (England and Wales). ii + 34 pp. Keyworth: British Geological Survey. Price £9.00 (paperback); including map £18.00. ISBN 978 0852 72565 8.

BRITISH GEOLOGICAL SURVEY. 2006. *Lampeter. England and Wales Sheet 195. Bedrock and Superficial Deposits. 1:50 000*. Keyworth: British Geological Survey. Price £12 (folded and cased); including Sheet Explanation £18.00. ISBN 0 7518 3466 1 (flat); 0 7518 3467 X (folded and cased).
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The Lower Palaeozoic rocks of Wales have become, over the past twenty years, a classic example of sedimentary basin fill in a transtensional tectonic setting. The initial mapping work towards this basin model was done piecemeal in a series of Ph.D. theses. Proper illustration and detailing of the model awaited the comprehensive surveys of the Geological Survey. The first phase of this work mapped the east to west transect comprising the Rhayader (179) and Llanilar (178) sheets, published in 1993 and 1994. This mapping showed the way in which sediment was supplied first northwestward from the Midland Platform and then northeastward along the basin axis. It magnificently portrayed how successive turbidite systems were ponded within different fault-bounded transtensional tilt blocks. It illustrated the strong control by these same faults on the structural style due to the later Acadian shortening.

The focus of Geological Survey work then moved southwards, to the transect between the Cardigan sheet (193; published 2003) and the Builth Wells sheet (196; 2004). The missing links in this cross-basin section are now provided by the maps for Llangranog (194) and Lampeter (195). The section provides ample confirmation of the basin model derived further north. The southeastward migration of the southerly-derived Silurian turbidite systems is perhaps even better displayed. The basement-rooted structural lineaments that define the elongate sub-basins are more abundantly evidenced; from the Tywi Lineament in the southeast, over the Central Wales Lineament and the Teifi Anticlinorium, to the Glandyfi Lineament in the northwest. A bonus in these southern areas is certainly the complex Quaternary deposits, straddling the area of influence of both the Irish Sea glacier and the Welsh ice cap. Indeed, it was the land-use and environmental aspects of the Quaternary, rather than of the bedrock geology, that attracted external funding for some of the mapping effort.

Although BGS 1:50 000 sheets necessarily have a fairly standard format and style, they do evolve in subtle ways through the years. We have now got used to their being accompanied by the short 'sheet explanations' rather than by lengthy memoirs, and these are very adequate for the general user. We are also finding more diverse marginalia to the main map: both the Lampeter and Llangranog sheets include informative 1:150 000 digital elevation models of the topography. However, the most momentous change on the new maps is the most subtle; their labelling not as 'Solid and Drift' editions but as 'Bedrock and Superficial Deposits'. We can recognize that the new terminology is more internationally acceptable, whilst admitting some nostalgia for the lost link with the biblical flood.

The new maps deserve a larger volume of sales than they will get in this relatively little-visited region. The Lampeter sheet in particular might make an interesting teaching map, but the abundant 'drift' makes 'solid' relations a challenge to abstract. Any buyer should note that there is a discount of £3 for buying the map and its sheet explanation together.

Nigel Woodcock

ERWIN, D. H. 2006. *Extinction. How Life on Earth Nearly Ended 250 Million Years Ago*. ix + 296 pp. Princeton, Oxford: Princeton University Press. Price US $24.95 (hard covers). ISBN 0 691 00524 9.
doi:10.1017/S0016756807003676

This book is pitched at an educated general readership and is written in an autobiographical first-person memoir style. Erwin conveys a powerful sense of story for this great whodunit mystery and lay readers will find it a good read. I did however find the level of self-aggrandisement in the book a little hard to swallow and there are several specific denigrating personal comments that I am surprised the editor allowed. Erwin also denigrates scientific rigour to 'technical trivia' (p. 264) where he also suggests that most geologists would find this rigour too pedantic.

However, Chapter 2 is an excellent introduction to possible causes for the end-Permian mass extinction and invites the reader to make up his own mind after reading all the arguments. Chapter 3 held great promise and interest.

Unfortunately it is riddled with scientific factual errors. For example, the species *Hindeodus parvus* (first appearance of which is used to define the base of the Triassic and hence the P–T boundary) is *not* 'now *Isarsica parvus*' (p. 74). Some authors place this species in the genus *Isarcicella* but most, as in fact Erwin himself does throughout this book, would retain this in *Hindeodus*. Erwin even gets the generic name wrong as '*Isarcica*' (specific name for *Isarcicella isarcica*).

Chapter 4 focuses on vital timing aspects. Erwin unfortunately embroils himself in ongoing disputes relating to the ages of ash beds in boundary sections in China. He promotes the contribution of himself and his colleagues whilst denigrating other equally important parallel studies and clings on to the outdated and inaccurate Bowring 1998 P–T boundary age and timescale. Bowring has now acknowledged that his initial dates at Meishan were too young and now agrees with the Mundil *et al.* (2004) age of 252.6 ± 0.2 for the mass extinction (Crowley *et al.* 2006), which is also accepted by the IUGS/ICS Permian and Triassic Subcommissions. Chapter 5 explores how physiology of organisms may have dictated their demise or survival in the extinction and what kinds of organisms were particularly affected. Again this chapter suffers from lack of attention to detail (e.g. Guang Rong Shi's name misspelled as 'Guirong Shi').

Erwin rightly points out in Chapter 6 that the end-Permian extinction *did* have a major effect on land with major implications for constraining suggested causes. His description of the Karoo, Rubidge family, and history of vertebrate studies are a delight to read. Chapter 7 focuses on the changing chemistry in oceans and atmosphere and for me was the best chapter in the book. The author discusses the important question as to whether changes in the carbon cycle reflect the causes of extinction or are the result of the extinction itself. Chapter 8 is the keystone chapter of this whodunit book. Erwin dogmatically states that the rapidity of extinction 'is beyond doubt' and 'probably occurred in less than a few hundred thousand years'. We need more high-precision and accurate data to confirm this. Erwin does a good job of assessing current front-runner causative mechanisms and then considers Siberian massive volcanism and impact as the two main contenders, rejecting impact as implausible, and favouring the massive volcanism scenario which has been championed by Paul Renne and others for many years. I was somewhat disappointed that the author did not pursue his multiple-cause scenario a little more, for I believe this is perhaps where the ultimate answer may lie. Chapters 9 and 10 are something of an anticlimax but do contain useful discussions of important issues of delayed recovery.

With similar readership target, focus, style and structure, Erwin's book begs comparison with Benton (2003). While covering similar ground, the books are complementary in providing different perspectives on one of science's greatest unsolved mysteries. I thoroughly recommend both to a general readership, but for the specialist Earth Scientist I think Dr Erwin's book needs tightening up in the second edition before it will appeal.

Ian Metcalfe

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BEERLING, D. 2007. *The Emerald Planet. How Plants Changed Earth's History*. xvi + 288 pp. Oxford, New York: Oxford University Press. Price £14.99 (hard covers). ISBN 9780 19 280602 4.
doi:10.1017/S0016756807004086

In most books dealing with the history of life, fossil plants comprise the fuzzy backdrop to a zoological drama of 'hopeful monsters'. At best, they may be permitted to give a static performance and mumble through a few disjointed lines. That's why David Beerling's new book – which brings plants onto centre stage – is so refreshingly novel. Through three hundred well written pages and seven geological case studies, Beerling emphasizes plants as a dynamic agent in the Earth's system, simultaneously shaping the global environment while responding to extrinsic selection pressures.

Over the past fifteen years, Beerling's research group has spearheaded a powerful new movement in the field, uniting plant physiology experiments with traditional palaeobotany to help interpret the vagaries of geological history. His thought-provoking book is essentially a popular review of that singular perspective – though none the worst for that. What is slightly awkward is the way he always discusses his own research in the third person, thereby excluding the possibility of personal anecdotes that might have enlivened the text. However, this is not a big issue because the book is replete with historical references, which in telling the story, manage to weave together an improbable miscellany of characters from birth control pioneer, Marie Stopes, to the Antarctic explorer, Robert Falcon Scott.

The seven chapters that comprise the core of this book address some of Beerling's main contributions to the field. The first considers how plants acquired leaves in order to resist 'suffocation' in an atmosphere scrubbed of carbon dioxide. The next two deal with a blip in planetary regulation that resulted in oxygen levels shooting up and promoting gigantism in insects and then plummeting, leaving the ozone shield vulnerable to depletion. Three more chapters focus on the Mesozoic greenhouse world and amongst diverse topics explore how forests managed to flourish at the poles beneath the midnight sun. A final chapter describes the metabolic innovation that allowed grasses to take over the planet in late Miocene times.

As Beerling freely admits, his book is not a traditional story of plant evolution, nor is his outlook free from controversy or critics. Nevertheless it does neatly capture the prevailing zeitgeist. The underlying motivation for Beerling's work is that by better understanding the role that plants played during extreme episodes in Earth history we are better equipped to understand the changes that might occur in response to global warming, or some other environmental excursion. For David