

These perceived deficiencies are addressed in many of the remaining 18 articles on studies of Permian to Mid Triassic continental sandstones of aeolian and fluvial origin that are organized under the headings of Flow, Unsaturated Flow, and Pollutant Movement.

Flow: The influence of geological factors on flow is emphasized in nine studies that cover the Dumfries Basin aquifer (SW Scotland), the Brockram, Penrith Sandstone, and Sherwood Sandstone Group (SSG) formations in Cumbria, and the SSG elsewhere in England. The distribution of porosity and permeability in the Penrith Sandstone is related to subtle variations in rock fabric; pore geometry in that unit and in SSG formations in the Cheshire Basin, central Midlands and Devon was studied using spectral induced polarization. Other studies of SSG formations cover permeability in contrasting lithofacies in the mainly aeolian Wilmslow Sandstone and succeeding mainly fluvial Helsby Sandstone (Cheshire Basin), factors affecting flow in the Wildmoor Sandstone (central Midlands) and hydraulic conductivity in the SSG in E Yorkshire, and the effect of calcrete on conductivity in the Otter Sandstone in E Devon, which is a hydrocarbon reservoir farther east in the Wytch Farm field. The effect of fault seals, well-known in relation to hydrocarbon production, has only recently been recognized in groundwater management in W Lancashire, the Wirral, Merseyside and N Cheshire where the SSG aquifer is compartmentalized by faults.

Unsaturated Flow: A study of fully- and partially-saturated Wildmoor Sandstone (SSG, central Midlands) found that the Waxman–Smits and Hanai–Bruggeman models give better characterization of the rock's electrical properties and correlation with independently determined hydraulic properties than Archie's oil-field-oriented model. Saline tracer migration in unsaturated SSG in Yorkshire was followed using 3-D cross-borehole electrical resistivity, and pore-water concentration changes were estimated by combining resistivity and cross-borehole radar tomograms.

Pollutant Movement: Among the seven contributions in this section a study of non-reactive solute movement through undisturbed, laminated, saturated samples from the SSG in Merseyside and Worcestershire highlights the importance of diffusion; and investigations into the source of arsenic concentrations in water from SSG formations in a borehole in Cheshire, the causes of variations in nitrate concentrations in the Penrith and St Bees Sandstone aquifer in the River Eden valley, Cumbria, and the identification of the source of saline groundwater in the SSG aquifer at Selby (Yorkshire), using oxygen and sulphur isotopes, are reported. A study of dense-non-aqueous-phase liquid (DNAPL) contaminant transport using samples from the Vale of Eden, W Lancashire, the Cheshire Basin, Yorkshire, Lincolnshire, the central and E Midlands and the Hampshire Basin showed that only 5% DNAPL may reduce permeability significantly and that a DNAPL saturation of *c.* 60% inhibits water flow. Two related contributions on a kerosene leakage into an aeolian sandstone aquifer reveal that initial remediation objectives for its management were based on incorrect assumptions because a model applicable to the movement of light non-aqueous-phase liquids in a granular medium, that has been understood by the hydrocarbons industry for some 50 years, was not properly appreciated by the UK groundwater remediation sector.

The volume is well illustrated and, though containing some editorial and typographical flaws and inconsistencies, is a welcome contribution on this important subject. It is recommended to fluid flow specialists and geologists alike.

Geoff Warrington

VICKERS-RICH, P. & KOMAROWER, P. (eds) 2007. *The Rise and Fall of the Ediacaran Biota*. Geological Society Special Publication no. 286. viii + 456 pp. London, Bath: Geological Society of London. Price £95.00, US \$190.00; GSL members' price £47.50, US \$95.00; AAPG/SEPM/GSA/RAS/EFG/PESGB members' price £57.00, US \$114.00 (hard covers). ISBN 9781 86239 233 5.
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The Neoproterozoic and its boundaries are hot topics at the moment. The UNESCO IGC Project 493 has been looking at the Neoproterozoic, the precise timing of its events and the effects of changing climates, environments, their chemistry and palaeogeography of the biotas of the time.

Over recent decades the problematic nature, timing and correlation of Neoproterozoic events have become increasingly discussed as have the equally problematic Ediacaran/Vendian biotas. More and more fossil forms have been recovered from the coastal exposures of Russia's White Sea (e.g. new data on *Kimberella* by Fedonkin *et al.*, in the volume under review) and Newfoundland. Even the better-known classic areas of the Flinders Ranges in Australia (see Jenkins & Nedin's contribution) and Namibia are still producing some surprises.

The global distribution of Ediacaran strata has meant that many geologists and palaeontologists from different countries have made contributions to the debate and as a result the literature is scattered across a huge range of journals. *The Rise and Fall of the Ediacaran Biota* is particularly useful in representing a collection of papers from two IGCP 493 interdisciplinary symposia, one in Prato, Italy in 2004 and the other in Kyoto, Japan in 2006. Some 70 authors from around the world publish contributions that range from general geology, stratigraphy and correlation to palaeontology, including some general discussions such as poriferan paralogy (Sperling *et al.*) and bilaterian body plans (Valentine). Abstracts of papers that were presented at the meetings but are not published here can be found on the Geological Society website (www.geolsoc.org.uk/SUP18273).

No matter whether you are particularly interested in geochemistry, glaciation or the biota, there will be some contributions of interest here with references to literature that otherwise can be difficult to access. The volume is well illustrated and indexed and generally up to the usual high production standards that we have come to expect from the Geological Society publishing house.

Douglas Palmer

HILLAIRE-MARCEL, C. & DE VERNAL, A. (eds) 2007. *Proxies in Late Cenozoic Paleoclimatology*. Developments in Marine Geology Series Volume 1. xviii + 843 pp. + CD-ROM. Amsterdam, Boston, Heidelberg, London: Elsevier. Price £68.99, US \$120.00, Euros 100 (hard covers). ISBN 9780 444 52755 4.
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This is an edited volume, in which an array of acclaimed specialists is allowed to showcase their expertise. An impressive array of proxies is discussed and elaborated. Appropriately, the book starts with a definition in the introductory chapter of what a proxy is: 'A measurable property of an environmental/geological record which, through mathematical or statistical treatment, can be related with a stated uncertainty to one or a combination of physical, chemical, or biological environmental factors during its formation'. It is important to note

that most of the book – although it can get very technical – is actually more accessible than that definition.

The concept ‘proxy’ has fortunately been interpreted in a broad sense by the various authors. That is appropriate, since palaeoceanography and palaeoclimatology rely as much on qualitative information as on quantitative information, and many of the proxies discussed have advanced the science by providing great qualitative information about past environments and constraints to natural processes. By including these aspects in the various chapters, the assorted authors have admirably succeeded in providing a sound context of developments that underlie the state-of-the-art quantification efforts.

The book runs through almost all of the major techniques applied in palaeoceanography. Some chapters seem a bit heavy on topics that the authors themselves work on, while other relevant aspects remain somewhat underrepresented. This is understandable, and if every little application had been included, then the book would have become at least twice as long as the 800+ pages it is already. It would also have lost its focus, and it is the focus and attention to detail that makes this book into an impressive reference work. All chapters progress from general background to salient details that will be useful to a wide readership on a graduate level. The book would be less suitable for undergraduate teaching, except if supported by extensive background teaching to each chapter. The extensive reference lists that are given with each chapter offer extremely valuable directions for further study. A CD is included with the book. It contains only good-quality pdf files of the figures and does not offer the type of PowerPoint support that many recent undergraduate-level textbooks have been spoiling us with. In the introduction, the book is presented as a graduate level (and above) text, and in my assessment it has been pitched exactly right. The consistency of level that has been achieved between virtually all chapters is a credit to the editors, and of course also the authors.

What do I miss? I think for a graduate level text, some worked examples on the CD or an accompanying website would have been nice. These might have been simple scripts or spreadsheets in which graduate students (and researchers) could work their way through basic examples, so that they would not just read about these exciting proxies, but also learn how to start working with them and thus develop a true understanding. I also miss – and this a bit of a personal hobbyhorse – attention to the wealth of proxies that is being used for sea-level reconstructions, but perhaps this was considered to be more appropriate for the ‘applied’ successor volume. Finally – and this is the only real omission in my view – there is not enough attention to the various problems, challenges, uncertainties, and sources of error. Sure, they get mentioned here and there, but rarely do they get a systematic treatment. If palaeoceanography and palaeoclimatology are to develop into proper quantitative disciplines, then the uncomfortable issues of uncertainties and error-propagation need to be tackled head-on. Calibrations are not the end of the story. Very often in these disciplines, one calibrated proxy gets compared with another calibrated proxy (or several times over, and – worse – the proxies are often not fully independent from one another). However, proper error-propagation is commonly omitted,

being replaced by a very favourable and rather subjective account of a mostly qualitative assessment of combined uncertainties. This book could and should have helped to train this bad habit out of the next generation of researchers, but in my view it has largely missed that opportunity.

Despite my little grumbles, I am overall very impressed with this book. I am positive that it will prove to be an extremely valuable reference book for anybody with an interest in reconstructing the past workings of the oceans and their involvement in climate change. I hope it will be accessibly priced and that paperbacks will be made available.

Eelco J. Rohling

LINNEMANN, U., NANCE, R. D., KRAFT, P. & ZULAUF, G. (eds) 2007. *The Evolution of the Rheic Ocean: From Avalonian–Cadomian Active Margin to Alleghenian–Variscan Collision*. Geological Society of America Special Paper no. 423. viii + 630 pp. Boulder: Geological Society of America. Price US \$149.00 (paperback). ISBN 9780 8137 2423 2.
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The opening and closure of the Palaeozoic oceans that lay between equatorial Laurentia and the southern polar Gondwana continue to fascinate geologists. The geological history of this region would have been simpler if there had only been one ocean between these two continents. As we now know, there was one other major continent (Baltica) and over a dozen microcontinents that complicated the intervening area. Most of these fragments were rifted off the Gondwanan margin and drifted northward to accrete with Laurentia. Baltica and the archipelago comprising the Rheno-Hercynian zone and Avalonia separated two oceanic branches. For a time, the research community was pre-occupied with the northern branch, the Iapetus Ocean. More recently, attention has shifted to the southern branch, the Rheic Ocean, whose closure culminated in the Late Palaeozoic Variscan Orogeny.

International Geological Correlation Program (IGCP) Project 497 has done much to coordinate research on remnants of the Rheic Ocean and its margins, now scattered across five continents. The present volume collects together research papers given at five meetings of this project held between September 2004 and July 2005. As is usual with such compilations, there is a mixture of content from reviews of substantial parts of the orogen to detailed studies of one small sector. However, the geographical spread is very broad. Iberia and the Mexican terranes are best represented (five papers each), with strong showings from the Saxothuringian and Barrandian zones (four papers each) and from South America (three papers). Other areas are represented by single papers only: Western Avalonia, Far Eastern Avalonia, Armorica, Baltica, North Africa, the Proto-Alpine terranes and Siberia. The volume will naturally arrive in many libraries as part of the Geological Society of America’s special paper series. Geologists who work on Palaeozoic palaeogeography and tectonics will certainly want access to a copy.

Nigel Woodcock