

BOOK REVIEWS

MATHER, A. E., MARTÍN, J. M., HARVEY, A. M. & BRAGA, J. C. (eds) 2001. *A Field Guide to the Neogene Sedimentary Basins of the Almería Province, South-East Spain*. International Association of Sedimentologists Field Guide Series. vii + 350 pp. Oxford: Blackwell Science. Price £25.00 (paperback). ISBN 0 632 05919 2. *Geol. Mag.* 139, 2002, DOI: 10.1017/S0016756802217112

Groups from universities and companies have been increasingly discovering the advantages of southeast Spain for geological field learning. Amongst the advantages are: dry and sunny field conditions, excellent variety of field geology, arid climate quality of exposures, and costs that compare well with those of visiting northwest Scotland or western Ireland for those living in the lowlands of Britain or north Europe. A disadvantage is that it is too hot in high summer. Another disadvantage has been largely removed by the publication of this book; it no longer lacks a general published guide in the English language.

This guide is concerned with the eastern end of the main Betic orogenic belt, a compact area, about 60 by 60 km, northeast of the city of Almería. All the localities lie within the province of Almería which, both inland and on the coast, is one of the least developed areas of the Spanish Mediterranean margin.

The title indicates a prime concern with the Neogene sedimentary basins of the area, and these basins provide much of the tectonic framework to fieldwork in the area. But there is a danger that some potential readers may not realise that there is also serious treatment of the metamorphic outcrops of one of the Sierras and of the extensive Neogene volcanics that occur particularly in the sierras of the Cabo de Gata coast. The metamorphic section (by Gomez-Pugnaire) describes the evidence for high-pressure regional eclogite metamorphism followed by lower-pressure phases. The section on the Neogene volcanism (by Fernandez-Soler) covers not only the extensive calc-alkaline areas, but also the more localized peraluminous and ultra-potassic centres. As in the case of other chapters of the guide, general summary and synthesis are followed by details of recommended stops, with maps, photographs and drawings. Details of maps, road access, etc., are also provided. These sections on the metamorphic basement and the Neogene volcanics are in a chapter on the Development of the Neogene basins, and this also includes sections on young regional deformation and on the Late Miocene evolving turbidite systems of the Tabernas basin (Haughton). This last topic has long attracted oil company geologists to make visits to the spectacular bad lands of the Tabernas area, and the new survey provided here is particularly welcome.

Major chapters follow the large chapter on the development of the basins. These deal, in approximate time sequence, with the ‘Shadow marine sedimentation’ (largely Late Miocene, by Martin & Braga), the ‘Marine to continental transition’ (largely Late Miocene to Pleistocene, by Mather & Stokes), and the Quaternary (by Harvey). Martin & Braga provide full, up-to-date accounts of the marine carbonates, evaporites, superb fringing reefs, and basal cyclic marls and sapropels, for which the Sorbas basin is justly famous. Mather & Stokes describe the alluvial fans, terraces

and river captures to be seen in this tectonically active setting. Harvey’s section is entitled ‘Uplift, dissection and landform evolution’, and provides a clear account of linkages between regional outcrop stratigraphy and geomorphology that can be made in areas such as this.

This is a very careful and full compilation, providing 350 pages of information and ideas, so it must not be dismissed as an ephemeral field guide. It represents the long-term collaboration of the editors from their bases in Plymouth, Liverpool and Granada, work that has been extending greatly our knowledge of one of the most recently active areas of the European crust. Acknowledgement is also made of the contribution of the Field Centre at Urrea, near Sorbas, where Mrs Lindy Walsh has done much to nurture the collaboration that has produced this book.

Peter Friend

BENTON, M. J., COOK, E. & TURNER, P. 2002. *Permian and Triassic Red Beds and the Penarth Group of Great Britain*. Geological Conservation Review Series no. 24. xvi + 337 pp. Peterborough: Joint Nature Conservation Committee. Price £62.00 (hard covers). ISBN 1 86107 493 X. *Geol. Mag.* 139, 2002, DOI: 10.1017/S001675680227119

This book is not a description of the Permian and Triassic red beds and the Penarth Group of Great Britain but rather is a series of descriptions of red-bed localities in or around the different basins of red-bed deposition; there are, or will be, considered for notification as Sites of Special Scientific Interest (SSSIs). Descriptions of these sites are augmented by other Regionally Important Geological/Geomorphological Sites (RIGS) that have educational, historical (e.g. first described in early 19th Century publications), research or aesthetic value. Although all the sites in this volume have been proposed for notification as SSSIs, the final decision to notify or re-notify sites lies with the governing councils of the country conservation agency concerned. The sites can be tabulated as follows:

| | Permian | Triassic | Penarth |
|---------------------|---------|----------|---------|
| Scotland | 5 | 6 | – |
| NE England | 1 | – | – |
| W. North Sea Basin | – | 4 | – |
| Cumbria | 7 | 1 | – |
| E. Irish Sea Basin | – | 4 | – |
| Cheshire Basin | – | 5 | – |
| English Midlands | 3 | 6 | – |
| S. Wales | – | 4 | 2 |
| Somerset/Gloucester | – | – | 9 |
| Devon | 7 | 2 | 2 |
| Total | 23 | 32 | 13 |

The opening chapter is a global introduction to the Permo-Triassic and Britain’s place within it (26 pp.). In the three succeeding chapters, British Permian red beds (72 pp.), the Triassic red beds (109 pp.) and the Penarth Group

(56 pp.), the sites are introduced at varying length. For the uninitiated, there is a useful 13-page glossary explaining technical terms, which is preceded by 26 pages of references.

Each site entry follows a similar pattern under the headings: introduction, description, sedimentology, palaeontology (if appropriate), interpretation and conclusions. This means that within each entry of a regional group there is inevitably repetition between the introduction and conclusions concerning at least the importance of the site – they are all important, but some more so than others. In a number of areas, similar sequences have much the same sedimentological and stratigraphical build-up including, where present, much the same fossil assemblage. From a reviewer's point of view this tends to be boring but is essential as a full description of each site must be recorded in order to evaluate its importance as a site of national or international interest.

Because authors in general tend to be very selective of what they choose to describe from individual sites, many have not been described in detail in the geological literature for a century or so, whereas others have had several descriptions made of them during the past 50 years. The reasons for each selection, whether peculiarities of sedimentology, the importance of fossil finds (anything from palynomorphs through crustaceans and brachiopods to dinosaur bones), or a first description by Murchison, Sedgwick or De la Beche), differs with each site and involves information that is not available in most books of a more general nature. The volume, therefore, represents an important reference contribution to Britain's Permo-Triassic geology.

As implied above, much work has gone into compiling many separate recommendations for consideration as a site of special scientific interest. There are useful location maps, geological sketches, columnar sections and stratigraphic tables. The value of the book has been reduced, however, by rather poor reproduction of many of the photographs to such an extent that it is sometimes difficult to discern what is described in the caption. Presumably following much the same text as in the original draft recommendations, occasionally the authors altered the word order of some sentences without deleting the word(s) in its (their) former position. Other sentences might have been clearer if the word order had been changed (use of multiple adjectival nouns before the main noun).

Reviewers are allowed the occasional niggles; I have several: p. 16: did flash floods in the British Permian result from monsoonal (wind reversal) conditions? p. 18, and several later occurrences: the presence of salt and dolomite is equated with a marine environment of deposition. This may be so, but there are plenty of examples where these minerals, either individually or together, can be found in lake sediments (e.g. Great Salt Lake in Utah; Elk Lake, Minnesota; Umm as Samim, Oman; Permian Rotliegend of Southern Permian Basin). I would accept a marine interpretation for otherwise arid-climate sequences only if there is the additional evidence of undoubted marine fossils, as found in some Zechstein sequences. p. 22: the Ranns of Kutch are not flooded regularly by the Indus, but receive Indus muds during high storm tides after marine transport under the influence of winds of the Southwest Monsoon. p. 32: on Fig. 2.1, I would reverse the locations of 1 and 2; and on p. 34, Cummingstown is spelt as such and not Cummingstone. The complex dune patterns more likely support a wind from the NE rather than W, and most star dunes barely migrate, if at all. p. 38: the 'slumps' of Hopeman have a strong vertical component not in keeping with slumping. p. 41: the Geological Survey (Regional Guide, 1985) give the age of

the Mauchline volcanics as 275–272 Ma rather than the admitted doubtful age of 286 ± 7 Ma quoted by the authors. pp. 52–56: it was always Crime Riggs (with an 's') Quarry when I visited it, and not Crime Rigg. pp. 66–67: there seems to be a 45° difference in wind direction on succeeding pages – NW and W for the same site.

I was a little shocked to find that in my copy of the book, p. 176 was succeeded by p. 189, p. 200 by p. 177, and 188 by 201. But at least nothing was missing. On p. 169, however, there was a vertical weakly printed stripe. I hope that other copies were not marred by such features.

Although most of these niggles are of a very minor nature, they suggest that the authors prepared their write-ups of individual sites in draft and then did a fairly hurried job of trying to tailor the compilation into book form without double checking everything; occasionally the meaning is uncertain. Even so, the book overall is of considerable value. Although most students of the Permo-Triassic would not want to purchase their own copy, one should be available for quick consultation in a library when planning field trips. Even so, this book is not intended as a field guide to the sites, some of which, as in railway cuttings, are inaccessible, but to put on record the scientific justification for their conservation.

K. W. Glennie

ZHU, C. & ANDERSON, G. 2002. *Environmental Applications of Geochemical Modelling*. xiv + 284 pp. Cambridge, New York, Melbourne: Cambridge University Press. Price £75.00, US \$110.00 (hard covers); £27.95, US \$40.00 (paperback). ISBN 0 521 80907 X; 0 521 00577 9 (pb). *Geol. Mag.* 139, 2002, DOI: 10.1017/S0016756802237115

Geochemical modelling is an established research tool in the Earth Sciences but, increasingly, the methodology and approach is also being applied to practical environmental problems. The aim of this book, as stated by the authors, is to bridge the two worlds of academic research and environmental practice. Through the use of some well-chosen case history examples and a theoretical background, sufficient for the expert but not so daunting for the environmental practitioner, I believe the authors have achieved this objective.

The introductory chapter outlines some of the major environmental issues facing society: high level radioactive waste disposal, acid mines drainage, landfills, deep well injection of hazardous waste, aquifer recharge. Chapter 2 deals with model concepts and an outline of the types of geochemical models available. The thermodynamic background provided in Chapter 3 is both comprehensive and informative, and written in a readily digestible and readable style. It is certainly one of the better summaries I have seen on the topic to date. Computer programs and their availability are quintessential for geochemical modelling. Chapter 4 reviews the programs that are more widely available: MINTEQA2, PHREEQC, EQ3/6, NETPATH, SUPCRT92, SOLVEQ & CHILLER, MINEQL plus the commercial package 'The Geochemist's workbench'. Some of these codes are available on the CD accompanying the book, or as free downloads from the listed websites. Chapter 5 outlines what is needed to set up a geochemical model and how to interpret the modelling results. With reference to case history examples the remaining chapters (6 to 11) deal with various types of models introduced in Chapter 2: speciation and solubility modelling, modelling surface adsorption, reaction path modelling, inverse mass balance modelling, coupled reactive transport models and kinetic modelling. A single appendix

shows how to modify a database and there is a comprehensive list of references, including a number of useful websites.

The book contains a number of helpful diagrams and numerous examples of input and output data from the various modelling programmes. Text boxes are used effectively throughout to illustrate key points.

Overall, I found this a very user-friendly and informative book that has certainly increased my knowledge and appetite for experimenting more with geochemical computer models. It should be essential reading for anyone involved in research, postgraduate studies or professional practice in environmental geochemistry. It also provides a useful guide to other environmental practitioners such as hydrogeologists, engineers and regulators who wish to further their understanding of the principles and practice of geochemical modelling.

A. H. Rankin

WEITSCHAT, W. & WICHARD, W. 2002. *Atlas of Plants and Animals in Baltic Amber*. 256 pp. Munich: Verlag Dr Friedrich Pfeil. Price Euro 75.00, US \$98.00 (hard covers). ISBN 3 931516 94 6.
Geol. Mag. 139, 2002, DOI: 10.1017/S0016756802247111

The limpidity and beauty of fossil inclusions in amber speaks as much to the heart as the mind: apparently frozen and bathed in a golden light the exquisitely preserved insects seem paradoxically both immediate and terribly remote. If somehow, difficult to believe, this magic has passed you by, then this magnificent atlas is the perfect remedy. As indicated it is primarily a review, in colour, of the many taxonomic treasures that the Baltic amber has yielded. As is well known, the bulk of the fauna is insect, and here we see anew the wonders of preservation in such groups as the lace bugs, mayflies and termites. But the range is much wider, encompassing not only other arthropods, including the spiders and wood-lice, but also plants and from the vertebrates, the feathers of birds and fur of mammals.

When confronted, for example, with the immense eyes of a jumping spider, the raptorial forelimbs of a praying mantis, or the hitchhiking phoretic mites, it is difficult to step back from these local wonders and consider what the scientific messages of the Baltic amber are for the palaeontologist. Here, as Wolfgang Weitschat and Wilfried Wichard point out, the resurgence of research has tended to pose as many problems as solving existing questions. To start with, it is not even clear exactly what sort of tree produced the fluid resins that subsequently hardened about their entombed captives to form the amber. Most probably it was a relative of the monkey-puzzle trees, but to our eyes this would have been a strange-looking forest, not least because along the monkey-puzzles there was also a seeming abundance of oaks. So too with the fauna, especially the insects. As has long been recognized many of the living descendants are now found in areas of the world remote from the heartland of the northern European amber sites, such as Madagascar and southeast Asia. These dramatic biogeographic shifts are presumably a consequence of climate change, but this area deserves far more detailed study, not least to puncture some of the higher absurdities of vicariance biogeography with its leaden literalism inherited from the stultifying effects of cladistic orthodoxy.

This atlas, therefore, is a must for anyone with a serious interest in the life of the past. Not only does it offer a glittering gallery of palaeontological wonders, that throw up many unanswered questions concerning the terrestrial ecology of

this mid-Eocene biota (a date somewhat older than has generally been thought), but it also reminds us that, despite the relative familiarity of many of the forms, we are looking into a vanished world. And not only is it vanished in the sense of what we see today, but also vanishing in another way. Unless carefully protected, the fate of the collected amber with its precious inclusions is to crumble to dust as the apparently indestructible polymer unravels under the effects of oxygen and light. Perhaps there is another message from amber to take to our hearts rather than our minds.

Simon Conway Morris

PIQUÉ, A. 2001. *Geology of Northwest Africa*. Beiträge zur Regionalen Geologie der Erde, Vol. 29. Translated by M. S. N. Carpenter. xiv+310 pp. Berlin, Stuttgart: Gebrüder Borntraeger. Price Euros 86.00 (hard covers). ISBN 3 443 11029 0.
Geol. Mag. 139, 2002, DOI: 10.1017/S0016756802257118

Although a relatively compact volume of 310 pages, the *Geology of Northwest Africa*, by Alain Piqué, is a far-reaching compendium of regional geological data. It is divided into two major sections: 'The structural domains of North Africa' and the 'Geodynamic evolution of the Maghrebian domains'. Each of these is further subdivided, by up to four or five decimal points, and to some extent gives the book the feel of a seminal doctoral thesis, although you could argue that '1.6321.1 The flysch units' is easier to find as a result of this dedication to detail.

Section 1 dedicates almost 50 pages to 'The West African Craton and its margins', and having written several proprietary reports on this area and wandered over the rocks of this area for a decade or more I only wish that the book had been published 20 years earlier. As one would expect, Piqué draws strongly on French literature for this and other chapters but the excellent translation by M. S. N. Carpenter results in a seamless transfer of information to the reader, although the presentation of a plethora of facts and geological terminology necessitates several passes, if one wishes fully to understand the detail of a particular region, geological succession or event.

In Section 1 the Mesetas, Atlantic Chain, Atlantic Margin and Rifo-Tellian are all dealt with an equal thoroughness and are generally well illustrated with diagrams redrawn from the originals by the author. Specific diagrams, however, have been oversimplified and data are sometimes missing. The approach adopted by Piqué is such that there is little room for the discussion of different or alternative interpretations and as a consequence some regions and topics could be perceived as dated. An abundance of well drawn cross-sections and palaeogeographic maps counterbalance this minor problem and geologists new to the region will find this volume an invaluable starting point.

In Section 2 the major topics are the Panafrican Orogeny (2.2); Distension of end-Proterozoic and basal Palaeozoic terrains (2.3); The Palaeozoic and Hercynian orogenic cycle (2.4); Opening of the Central Atlantic: rifts and troughs in the Triassic and Jurassic (2.5); and Convergence between Africa and Europe (2.6). Each section consists of a number of short essays that draw together plate tectonics, orogenic cycles and regional events. They follow a logical trend from west to east across the region and provide an excellent summary of the tectonic history of the terrains of Northwest Africa and adjacent areas.

The references are a reflection of the hard work put in by the author and the vast majority reflect the continued inter-

est in this fascinating and complex region which is forever open to new interpretations. There are notable omissions, however, and some reference to the on-going work on the Tethyan region at the University of Lucerne would have strengthened the second part of the book.

Overall Alain Piqué must be praised for his magnificent effort in bringing together so much information on Northwest Africa. The book is a must for both researchers and explorationists.

R. T. J. Moody

ARNÓRSSON, S. (ed.) 2000 *Isotopic and Chemical Techniques in Geothermal Exploration, Development and Use*. x + 351 pp. Vienna: International Atomic Energy Agency. Price Ös 1070.00, Euro 77.76 (paperback). ISBN 92 0 101600 X.
Geol. Mag. 139, 2002, DOI: 10.1017/S0016756802267114

This book, published through the International Atomic Energy Agency, is written largely by Stefan Arnórsson and Franco D'Amore, two leading European figures in geothermal research. As one might expect, it is a thorough and comprehensive work, reflecting the authors' wide-ranging experience in this field. The various chapters cover both the basic science which underpins the concepts used and their practical application to geothermal resources. The applications discussed cover all stages in the exploitation of a geothermal resource, from exploration and development through to monitoring of the response of a geothermal aquifer to production.

The introductory chapters set the focus of the book on practical applications of geothermal studies, an emphasis that remains strong throughout the rest of the book. The following background chapters present chemical definitions, introductory thermodynamics and principles of stable isotopes. These are not particularly easy going but are essential background to the rest of the book. In a sense the book is written rather as one might present a course in the subject. The book would be more easily readable (but less rigorous) if this material had largely been presented in Appendices rather than in the main text.

Once past this background material, the 'meat' of the book is generally extremely well written and presented. The treatment of isotopes in geothermal systems and chemical and isotopic components are both very good. There is an extensive section on sampling of geothermal liquids and gases which incorporates a wealth of practical detail and forms an important reference for sample collection and field analysis methodologies. Unfortunately the photographs and figures accompanying this section are relatively poor. Importantly, data quality and the factors affecting it are emphasized. The following chapter on geothermometry is also extensive; it gives a thorough grounding in the basic principles behind geothermometers and covers all the useful chemical and isotopic thermometers. Notes are included on the usefulness of different thermometers and their limita-

tions. A further chapter deals with the application of mixing models and how they can be used to assess deep hot aquifer conditions where there has been modification by mixing with cool shallow groundwater.

The chapter on wet steam wells explains phase separation and 'excess enthalpy' and how this process can be identified and realistic aquifer compositions calculated. A separate chapter deals with the effects of these processes on water and steam isotopic compositions. The chapter on mineral saturation is very well written and explained, making it very easy to follow. The chapter on calculation of aquifer steam fraction and gas chemistry is a very good summary – but may be hard going for the inexperienced. A critical examination is made of the different models used in these calculations and their limitations.

The final, and very important, chapter is on aquifer response to production. As the authors point out, geothermal energy is, at best, a semi-renewable resource, akin to 'mining' heat from the ground. Geothermometry and chemical and isotopic compositions can be used to assess changes in aquifer status during production. Temperature and pressure in wells may be buffered during the early stages of production by rock heat and/or boiling, in which case cold recharge will not be obvious unless chemical and isotopic changes are monitored. Monitoring is also important in the case of reinjection of cooled geothermal water, which is much preferable to surface disposal on environmental grounds.

This book has many strengths. Firstly, it is comprehensive. Because all the relevant chemical, isotopic and thermodynamic definitions and background are covered here there is little need for recourse to other introductory texts. To be fair though these sections would be very hard work for those without previous experience in these fields or who were not guided through them. Secondly, by acting as a 'handbook' of practice in geothermal investigations, it will ensure consistency of methodology and approach and thus facilitate comparisons with earlier studies. Thirdly, it has a strong practical bias. It is mostly written in a straightforward and workman-like way (by which I mean that practical applications guide the way in which material is presented). I feel that this will help to make the book accessible to a wider range of readers.

It also has a number of weaknesses. The photographs and some diagrams are of relatively poor quality. There is also a small number of annoying minor mistakes and ambiguities. Although alluded to in the introduction, the environmental effects of disposal of waste geothermal water are not covered and would perhaps have warranted a more detailed treatment.

On balance, however, this is an excellent book, which I would recommend to all with an interest in geothermal studies. It is written with the newcomer to the field in mind and would certainly suit students at M.Sc. level and upwards. It should certainly find a place in the libraries of departments where this material is taught.

Simon Bottrell