

REVIEW

An atlas of Carboniferous basin evolution in northern England. A J Fraser and R L Gawthorpe, 2003. Geological Society, London, Memoir 28. 96 pp large format, ISBN 1 86 239135 1, £55.

Traditional accounts of the Carboniferous of Northern England (ie north of Leicester) have commonly relied on the integration of surface geological studies with deep borehole data. However, within the last 20 years or so, our understanding of these strata has been extended into the subsurface dimension by a number of articles that link the borehole evidence into a vast network of seismic reflection profiles. These were created as a culmination of 70 years of exploration that has resulted in the discovery of 75 million barrels of recoverable oil reserves in Northern England. The authors have been at the forefront of the most recent work, and in this atlas they present a 'unique collection of onshore seismic data', mainly derived from the now-fragmented seismic database of British Petroleum. This is amply supplemented by interpretations, to produce a highly readable account of the complex interplay between plate tectonics, sedimentation and structure through Carboniferous time.

The layout of this atlas takes into account the needs of 'browsers', and of those who wish to build up their knowledge step-by step. Following the Introduction, Chapter 2 discusses the regional structural framework, commencing with a synthesis of the Precambrian and Caledonian structures that determined the locations of many important Carboniferous faults. Along such structures the Variscan tectonic cycle proceeded, creating rifted basins, burying them beneath sediment, and eventually uplifting or 'inverting' them. These events relate to a tectono-stratigraphic model, which divides the Carboniferous strata into three megasequences: syn-rift, post-rift and inversion, each deposited during a specific phase of the Variscan cycle. Megasequences are in turn subdivided into lower-order seismo-stratigraphic sequences, their boundaries recognised on seismic profiles by depositional breaks or by their pinching out along basin margins.

Chapter 3 is devoted to Carboniferous basin development, and it summarizes the seismo-stratigraphic sequences developed within several basins. The format of the atlas (405 x 305 mm, ring-bound) comes into its own here, because some of the interpreted seismic sections are very long when pulled out. East Midlands geology is well represented, with the Widmerpool Gulf chosen as the type example of a Carboniferous rifted basin. A useful tectonic synthesis correlates strata between different basins, from the East Midlands to the Tweed, setting their development within a time frame constrained by fossils found in boreholes through the various sequences. Formations

exposed at the surface, and named on geological maps, are mentioned where possible, but the seismo-stratigraphic approach does not lend itself easily to integration with conventional lithostratigraphy.

Geologists working with exposures or borehole material, and attempting to interpret depositional environments, should find Chapter 4 of most relevance, since it discusses the palaeogeography and facies evolution, through time, of the tectono-stratigraphic sequences. This account utilizes large-format palaeofacies maps showing much new detail. Some of these would have been better in full-colour, and in places the print is rather small and difficult to read.

The final Chapter (5), on play fairway analysis explains why all of this research has been done, because it is through the integration of structural and seismic sequence analysis that hydrocarbon fields are nowadays identified. The chapter takes the reader through the various hydrocarbon targets, or 'plays', that developed at different times within these basins as the Variscan tectonic cycle proceeded, analysing them for attributes such as source-rock, cap-rock and reservoir potential and structure. This is not just about the Carboniferous, however, because at the end of that period the Variscan uplifts inverted many of these basins, destroying existing oil accumulations and arresting further generation. In fact, the oil and gas exploited today was re-generated from Carboniferous strata as a consequence of their burial beneath an insulating blanket of Mesozoic (Triassic, Jurassic, Cretaceous) strata. This interplay between Mesozoic burial, oil generation, and the distribution of remnant Carboniferous basins is illustrated with a series of maps, the outcome being a play assessment making it clear that 'the geological history of the East Midlands, compared to the rest of northern England, is most favourable for the development of an oil province'.

At £55 this is not the cheapest of publications, but it is reasonable enough to be purchased by the libraries of all universities and organisations that include geology as a significant activity. The authors hope that the atlas will not only provide a paper record of a now-fragmented seismic data holding, but will be of value to researchers, to many in the oil industry, and to all those seeking to understand or to teach the concepts of basin tectonics and seismic sequence stratigraphy. Given that this is not an inordinately large publication, the attainment of all these objectives has been successfully achieved.

John Carney

REVIEW

The Geology of the East Midlands, by Albert Horton and Peter Gutteridge (compilers), 2003. Geologists' Association Guide 63. 128 pages of A5, 29 figures, 13 photos. 0-900717-89-0, £8 (£6 for EMGS members).

This guide was produced through a joint collaboration, written and prepared by members of the East Midlands Geological Society and printed and published by the Geologists' Association. It is a very welcome and much needed guide to an area encompassing a wide extent of country with geological exposures of great interest, ranging from the Precambrian to Recent. The guide had a prolonged gestation period, but now that it is safely delivered, the parent organizations can relax; all is well, and the authors, compilers and editor are to be congratulated on a job well done.

The guide is divided into three sections dealing with the Precambrian, Carboniferous and Permian- Jurassic periods. Each section is introduced by an essay setting out the geological history of the region in that period and setting the context of the excursions. For newcomers to the region these essays are a valuable introduction and geological orientation. The excursions of course are the substance of any guide. Though there may be differences of opinion as to the best choice of sites within such a wide and varied region as the East Midlands, these are generally well chosen and will take readers to eleven representative areas of great interest.

Each itinerary is well organized, with a preamble describing objectives and logistics for the trip, including useful telephone numbers to gain authorised access. The geological descriptions are lucid, sufficiently detailed and, useful for the beginner; all except one draw conclusions from the visible evidence as to the processes that underlie the geology. As on all geological field trips, points for discussion and dissension arise. Your reviewer should like to have listened to a discussion between Dr Editor Gutteridge and Dr Peak District Ford as to the stratigraphic placing of the mud mound at Locality 5 on the excursion to the Stone Centre. Where does it lie with respect to the Monsal Dale / Eyam Limestones boundary? A pleasing feature of all contributions is the close correlation made between the geological setting and the local industrial history that has provided the wealth of the region. In this respect, John Marriot's contribution on Holymoorside and that of Andy Howard on the Permo-Triassic of Nottingham are particularly enjoyable.

Illustrations are important in guidebooks and, not least, Tony Waltham's cover photos will surely attract buyers at the counter. In the text the photographs are generally of good quality, but some lack scale

markers, others are perhaps past their "sell-by" date, and the cleavage refraction is poorly demonstrated in Figure 7. The black-and-white line drawings and maps are excellent as are the coloured paleogeographic maps (though the colour coding in Figure 30 is wrong). There is an inconsistency in captioning of figures; some usefully indicate the location numbers, but others do not. This is inconvenient and confusing when the figure and the location it illustrates are five or six pages apart, as in the Middle Jurassic excursion.

The text is supported by a short glossary of geological terms used and highlighted in the text. In general these are succinct, one-line explanations and are helpful and informative for beginners, but their brevity leads to some problems. The definitions for dip and strike are so mutually circular that their meaning becomes elliptical, and the bald definition of epiclastic is hardly helpful. Zones of the Dinantian, not referred to in the text, are explained in the glossary; goniatite zones of the Namurian which feature in descriptions of several locations are not. It would have been helpful to have had a simple explanatory table(s) for these in the body of the text, much as in Wolverson Cope's G.A. Guide 26 to the Peak District.

There is a good further reading list for readers to follow up, but looking back through old G.A. guides there seems to have been a change in presentational style during the 1990's with replacement of formally referenced articles by a reading list. Perhaps there is something to be said for this in general terms, but your reviewer finds the older practice of specifically referenced articles more useful when going to the library, and points to G.A. Guide 44 on the Late Precambrian Geology of the Scottish Highlands as a model. Perhaps for future guides, a compromise might be reached with a short general reading list complemented by specifically referenced itineraries, and the Guide Series Editor may wish to consider this.

Two particular points for comment arise. The reference to Ford and Rieuwerts' *Lead Mining in the Peak District* indicates a new edition in preparation to replace the 3rd; but the new 4th edition was published in 2000, preceding this guide by almost three years and perhaps evidence of its prolonged gestation. Figure 15, a sketch map of the Stone Centre is drawn after Gordon Walkden, but no reference is made to Walkden's publications in the reading list. This omission is a pity, for they remain important and valuable accounts of the Wirksworth area.

This is an interesting and valuable guide which achieves its purposes well. Any infelicities are minor. It will serve to inform and enthuse those new to geology, and will induce those more experienced, to revisit sites and explore again with new eyes. Like all successful ventures, it raises the question "what next"? The East Midlands is surely big enough for a second volume, and this idea is commended to the parent bodies.

The prices of the Guide through the Society, to members at £6 and to non-members at £8, are remarkable value, particularly compared to the GA members' price of £8-50 and a retail shop price of £15. For once, the north-south divide is working in our favour, but then we don't have an office in Piccadilly opposite Fortnum and Masons! At EMGS prices, buy two copies, one for your library and one for wet field days.

Gerard Slavin

REVIEW

The practice of British geology 1750-1850, by H S Torrens, 2002. Variorum Collected Studies, Ashgate Publishing: Aldershot. 356 pp, ISBN 0-86078-876-8, £59.50.

This review is particularly appropriate in view of Professor Torrens' recent lecture to the Society on William Smith's practical geological activities. It is a collection of thirteen of Hugh Torrens' research papers (two with co-authors) on matters relating to the early evolution of geological science. The chapters are facsimile reproductions from other publications without any later editing and with original type-face and pagination. It is useful to have them all in one place, as some appeared in obscure overseas journals or conference papers. One chapter is in French and another contains several quotations in Italian: translations would have helped the reader.

The Mineral Surveyors of the late 18th and early 19th centuries were, broadly, prospectors who advised landowners on any rocks or minerals worthy of exploitation. They contributed to the advance of geology, but, as few of their reports were published, they have generally been overlooked by historians of science. The surveyors were often in financial difficulties, particularly after the Napoleonic wars when a general depression discouraged investment. A conflict with the gentleman geologists of the Geological Society of London led to much of the practical men's work being belittled if not ignored.

From intensive searches of contemporary correspondence and business records, Hugh Torrens has presented us with an intriguing survey of the activities of some of the Mineral Surveyors. The Irishman James Ryan invented the core drill for obtaining much better samples of the strata penetrated than the percussion drills used beforehand. He also founded a School of Mining in Montgomeryshire, possibly the first such school in Britain, though little is known about it. The Welshman John Williams and his part in coal prospecting are discussed in detail, especially his involvement in an abortive venture in Italy. Arthur Aikin's ambitious Mineralogical Survey of Shropshire (1796-1816) is described, though it was not completed and remained unpublished until Murchison used some of it in his *Siluria* in 1839. Not surprisingly William Smith, canal engineer, mineral surveyor and "Father of English stratigraphy", with his problems in getting both his stratigraphic ideas accepted and his great map published, come into the story, and there are frequent references to the role played in various projects by John Farey, author of the *General View of the Agriculture and Minerals of Derbyshire* (1811). Ford and Torrens' biographical introduction to the 1989 reprint of that great work forms chapter VI of the present collection.

Other early mineral surveyors discussed include J.H. Fryer, who was sent out to Peru to supervise British investment in the Potosi mines (before they became part of Bolivia), but seemingly never got there owing to political problems. There is a section on W.E. Logan, whose intimate knowledge of the South Wales coalfield was later incorporated in Henry De La Beche's early Geological Survey reports; subsequently Logan effectively founded the Canadian Geological Survey almost single-handed. Another section covers James Buckman who surveyed the Guyandotte coalfield of West Virginia where the investors found it difficult to believe the local geologists' reports.

Much of the mineral prospecting and mining material in the book is concerned with coal mining, a subject which Hugh Torrens referred to as being "papyrophobic": in its early days the mining fraternity was not keen on putting anything down on paper, particularly failures. The Mineral Surveyors were also much concerned with adventurers sinking trial boreholes and shafts in places where there was never any likelihood of finding coal, such as Bexhill in Sussex and Malmesbury in Wiltshire. It was not unknown for such boreholes to be "salted" by dropping lumps of coal down at dead of night!

This book should be on the shelf of all interested in the early development of both geology and mineral prospecting, particularly coal mining.

Trevor Ford

REVIEW

Northamptonshire Stone, by D.S.Sutherland, 2003. Dovecote Press: Wimborne. 128 pp, ISBN 1-904349-17-X, Softback £12.95 (+ £1.95 p & p from Dovecote, Stanbridge, Wimbourne, Dorset BH21 4JD).

Northamptonshire is a county entirely on Jurassic strata with many different limestones, sandstones, mudstones and ironstones dipping gently eastwards so that they crop out in narrow strips trending roughly SW to NE and along the sides of river valleys. A sheet of boulder clay covers the interfluvial areas.

In earlier times almost every village had its stone quarry that provided building material for castles, stately homes, churches and other buildings. Diana Sutherland has here carried out a thorough survey of which stone was used where, often in combinations for decorative purposes.

The stones are treated in stratigraphical order from the Liassic limestones up to the Upper Jurassic Cornbrash, and geological maps are provided for each group. She describes the petrographic details by which we can recognize the stones used, and records the locations of about a hundred quarries. Regrettably many of these were destroyed by ironstone working in the 20th century and others have been back-filled so that only a few are accessible today. Some of these are still producing stone though mainly for aggregate.

Special treatment has been given to the Collyweston Slate, a fissile sandy limestone mined in northeast Northamptonshire. Similar "slates" were obtained elsewhere, as at Duston, now beneath a Northampton housing estate. There is a chapter devoted to the Saxon church at Brixworth wherein various rocks from the Precambrian of Charnwood Forest were used, some apparently "recycled" from the ruins of Roman Leicester.

Details of quarrying and stone-working methods are somewhat hidden in locality descriptions. Weathering properties are noted, but nothing is said about physical properties such as crushing strengths. The latter would have been an unknown factor to mediaeval masons, and it is a testimony to their skill that so many buildings have survived.

This attractive book is liberally illustrated with colour photographs, and the printers have made a fine job of reproducing the subtle shades of brown, red, cream, white and grey. A glossary and index are included.

Trevor Ford

REVIEW

Geology of the Melton Mowbray district, by J N Carney, K Ambrose and A Brandon, 2002. Sheet Explanation of Melton Mowbray, England & Wales Sheet 142, Solid & Drift Geology 1:50,000, British Geological Survey. 34 pp A5, ISBN 0-85272-436-5, £9 (Map is £11, or a pack with both map and Explanation is £18).

This part of our home ground was resurveyed in 1997-99 by three BGS surveyors well known to most EMGS members - John Carney, Keith Ambrose and Allan Brandon. All three were EMGS members at the time, gave lectures or led field trips for Society members, and contributed to the Society's *Geology of the East Midlands* which includes this area.

The Melton sheet adjoins the Nottingham Sheet to the south and covers Melton Mowbray, Keyworth, NE Loughborough and the Vale of Belvoir. It follows the same format as the Nottingham sheet, so that both maps show an enormous improvement in clarity and amount of information compared to the older series. The geological map is accompanied by a very comprehensive generalised vertical section for the whole sheet. There are three cross sections on the map and a further three in the Sheet Explanation. Small scale Bouguer gravity and aeromagnetic anomaly maps of the sheet and surrounding area are included plus a schematic model illustrating the spatial relationships of the Quaternary deposits.

The 34 page Sheet Explanation, compiled by John Carney, is clearly and concisely written to provide a wealth of useful information. There are colour photographs of landscape features and of Lias group fossils and ten tables covering topics from the Carboniferous rocks to the Quaternary deposits, fossils and mineral deposits. The new map and its accompanying text will greatly enhance the understanding and appreciation of the area by any Society member who is interested in any aspect of the natural environment of the area.

Alan Filmer

REVIEW

Grand Canyon Geology, edited by S S Beus and M Morales, 2003, second edition. Oxford University Press: New York. 432 pp, ISBN 0 19 512299 2, paperback £29.50.

The book is a revision of the edition published in 1990, which was a successor to the book *Geology of the Grand Canyon* edited by W.J. Breed and E.C. Roat, published by the Museum of Northern Arizona in 1974. Curiously this is not mentioned, nor is it listed in the bibliography of the new edition. It may seem unusual for an author to review a book to which he has contributed, but the writer is only one of 37 authors, who has had no contact with the others, did not see their chapters until publication, and had no communication with his co-author, who revised the draft supplied several years ago.

Anyone touring the American Southwest, is bound to have visited the Grand Canyon probably seeing it from the viewpoints along the south rim. The first impression is of almost horizontal strata lying parallel for as far as one can see, but this is misleading, for there are many gaps in the stratigraphic record. This book presents a summary of many years of research. Down in the bottom of the canyon are several stretches, known as the Upper, Middle and Lower Granite Gorges, that provide the only accessible sections of the "basement" rocks in the region. They consist of gneises, schists and granite intrusions that are 1.8-1.4 billion years old, and this edition provides a new analysis arising from detailed research in the last 15 years. The rocks are of Older Proterozoic age and have been buried to a depth of at least 20 km by crustal processes. Subsequent uplift led to the erosion of the top 10 km yielding a Great Unconformity beneath the younger, unmetamorphosed, Precambrian sediments, which have ages of around 1200-800 million years, i.e. considerably older than our own Charnian rocks.

The details of the younger Precambrian indicate a range of environments from desert to lacustrine, and shallow to deeper marine. The marine beds yield a variety of fossils; the Chuar Group in particular contains thick shales, some black, with many microfossils (acritarchs). These shales are potential source rocks for hydrocarbons, but any accumulations near the Canyon would obviously have seeped out through the walls to be lost. Further away, such Precambrian hydrocarbons may still be trapped in structures beneath the Colorado Plateau but they have not yet been found.

The rest of the Grand Canyon walls are composed of Palaeozoic beds resting on the Great Unconformity that was noted by J.W. Powell on his historic boat trip through the Grand Canyon in 1869. However, there are many stratigraphic gaps. Above the thick Cambrian sequence, there are no Ordovician or Silurian beds, indicating a long period of emergence.



The eastern Grand Canyon, seen from Desert View; most of the middle ground is younger Precambrian sediments capped by Cambrian Tapeats Sandstone; the lower part of Marble Gorge is on the far right.

Devonian rocks are largely limited to fills of channels cut into the Cambrian, but they merge into a continuous dolomitic horizon in the western Canyon. Both Cambrian and Devonian are covered disconformably by Mississippian (Lower Carboniferous) limestones, but these represent two advances and regressions, with gaps representing non-deposition. Filling deep channels cut into the limestones are beds of the Surprise Canyon Formation, roughly the age of the British Millstone Grit, seen mainly in inaccessible cliff sections in the western Canyon. The Supai Formation, of Pennsylvanian age (roughly the same as the Coal Measures) at first sight looks like similar cyclothem though without the coals. However, the sandstones are mainly aeolian, not deltaic, and there are thin conglomerates marking the start of each transgression after breaks with no deposition. The highest beds are Permian, ranging from the massive aeolian Coconino Sandstone to red beds and dolomites, together not unlike the British Permian succession. All these Palaeozoic beds show evidence of thickening to the west and an increasing approach to a shoreline to the east.

Thick Triassic, Jurassic, Cretaceous and early Tertiary strata once lay above the Canyon's strata but these have been eroded off. They can still be seen in nearby Zion and Bryce Canyons and in the Painted Desert. The structural relationships to the basin-and-range province to the west and to the rest of the Colorado Plateau to the east are well-known, and are admirably summarized in this new edition. Thus the first half of this new book provides a comprehensive survey of the present state of stratigraphic knowledge in the Grand Canyon.

The second half is more concerned with the geomorphological evolution of the Canyon. The establishment of the drainage system across the

Colorado Plateau can now be dated more accurately at starting close to the Miocene/Pliocene boundary, around 6 million years ago. The Canyon had been eroded to its present depth in less than 5 million years, before the time of the volcanic eruptions whose earliest lavas tumbled into the western Canyon about 1.4 million years ago. Lavas from several eruptions filled the western Grand Canyon to depths of up to 420 m, thereby damming up lakes, at least one of which stretched the whole length of the Canyon. The lava dams were the sites of waterfalls higher than Niagara, and were eroded away remarkably quickly, possibly with catastrophic collapses and floods over a period of less than half a million years, except that sediment deposited behind the dams had to be eroded away as well; sediment relics survive in a few side canyons. The final chapters are mostly concerned with the origin and hydraulics of the famous rapids and with debris flows from the walls.

While this book provides a fine summary of the basic geology, there are gaps. There is no chapter on mineral deposits and mining (as there was in the Breed & Roat book of 1974). Asbestos was mined from metamorphosed dolomites above the Proterozoic sill above Hance Rapids; copper was raised from fault breccias at some two dozen localities, mostly in the early 20th century. Copper and uranium were obtained from breccia pipes resulting from solution collapse, one pipe being worked up to the 1950s. Guano mining from Bat Cave in the western Canyon is not discussed, nor are there descriptions of other caves, though karstic drainage affects much of the surrounding area with massive springs discharging into the Canyon or its tributaries. Massive movements of rock waste are described as debris flows but, surprisingly, the chapter does not cover rock falls or landslides. Discussion of the latter is in the wrong place, having been tacked on to the regional tectonic chapter, as are valley anticlines (usually known as valley bulges in Britain).



The central Grand Canyon, showing Upper Granite Gorge in the floor, walled by Mid-Proterozoic metamorphics and granitic intrusions that are overlain by horizontal Cambrian and Mississippian beds.



The western Grand Canyon, with the remains of two lava dams, just downstream of Toroweap Overlook.

Rock falls are not discussed though they can be spectacular – a joint block some 100 m high fell off the Coconino Sandstone near the South Rim village while the writer was there, and the raft trip operators report some twenty such falls each year. During one overnight camp after a heavy rainstorm, your scribe could hear rocks falling from the adjacent cliffs – an alarming experience when sleeping on a beach in the line of fire! Spring-head sapping at the base of permeable strata is not discussed as a factor in causing rock falls. Travertine deposits are widespread through the Canyon and its tributaries, but the only ones mentioned are those forming waterfalls in Havasu Canyon, and there is no comment that these tumble over the eroded ends of the sediment fill arising from the lava dams.

The book is liberally illustrated with black-and-white photos though Figure 21.12 is inverted. Typographic mistakes are few though *uncomformity* appears throughout Chapter 5. Finally, I looked in vain for a list of addresses or affiliations of the contributors. Some I know nothing about: others range from senior academics or USGS geologists to Masters students at Northern Arizona University. Notwithstanding the deficiencies, this is a fine book and well worth investing in if you are going to the American Southwest or wish to know more about what you saw on your study tour.

Trevor Ford