

of fundamental tectonic principles. Any attempt to summarize the geology of this entire region is a monumental task; to bring together different workers with diverse viewpoints and still produce a coherent volume is a huge editorial challenge. Happily the editors have been able to do both, presenting an overall balanced picture of the portion of this extensive mountain belt that lies in the United States, and allowing authors to present their diverse views so that readers can draw their own conclusions on conflicting interpretations.

The volume is divided into two parts, with the first 14 chapters (and plates 1–7, and 12) dealing with the Appalachians, and chapters 16–30 (and plates 8–11) devoted to the Ouachitas. Chapter 15 deals with subsurface information on the area where the two belts come together and clearly demonstrates them as being separate but overlapping (in space and time) belts. In spite of many similarities between the Appalachians and the Ouachitas and their traditional representation as part of a single chain (and therefore their inclusion in a single volume), what really stands out in reading the two parts of the volume are the enormous differences in lithology, stratigraphy and tectonic evolution between these two belts. Perhaps the two are part of a single chain in the sense that the Himalayas and the Zagros are part of a single chain.

The section on the Appalachians contains chapters on pre-orogenic terranes, the Taconic, the Acadian, and the Alleghanian orogens, post-Paleozoic tectonics, late Paleozoic thermal evolution, subsurface structure under the coastal plain, and shorter chapters on paleontological contributions, geophysical characteristics, geomorphology, mineral deposits and energy resources; the section ends with a tectonic synthesis. The authors of the chapters describing the orogens have tried very hard to cover all viewpoints and to leave interpretations and conclusions as open and subject to change as possible; this does result in enormously long texts, but is useful from the point of view of future research workers. The authors also point out the complexity and time-transgressive nature of the individual orogenic episodes and ask whether the traditional three-part orogenic history of the Appalachians should still be considered valid. Yet the volume does present the material in the framework of the traditional three-part history; on the one hand this makes it comfortable for most current Appalachian geologists, but on the other it makes it difficult for future workers to think about the Appalachians from new and different viewpoints. The chapter on pre-orogenic terranes presents considerable information on lithology and geochronology, but little or no information on Grenville or Avalonian deformation or tectonics; this leaves an enormous hole in the tectonic syntheses of the later orogens, not allowing the reader to see how the fabric and tectonics of the earlier orogens may have affected the tectonic development of the Appalachians. The final tectonic synthesis (Chapter 14) does pull together some of the other chapters, but depends too much on previously unpublished (other than Abstracts) material; it is presented as one possible tectonic scenario, and leaves the door open for other possible ones that the reader may want to think of.

The section on the Ouachita–Marathon belt has chapters on Paleozoic biostratigraphy, pre-orogenic stratigraphy and Carboniferous flysch deposits of the Ouachitas, pre-Permian rocks of the Marathons, Ouachita thrust belt, Benton–Broken Bow uplifts, subsurface Ouachitas under the coastal plain, Marathon fold–thrust belt, foreland structures, geophysical review and tectonic synthesis, with shorter chapters on mineral deposits and hydrocarbons. Once again the chapters are well written, attempting to present all viewpoints and leaving interpretations as open as possible. Like other orogens this one appears to have its own peculiar traditions: two that are quite obvious are the rather artificial subdivision of a single fold–thrust belt into longitudinal belts based on the stratigraphy exposed at the surface (with separate chapters devoted to each!), and the use of the term “uplift” to describe structures that are (from maps and cross-sections) clearly doubly-plunging culminations formed by stacking of imbricate thrust sheets. The geophysical review presents useful colored maps (plate 10) on gravity and aeromagnetic data; other maps and cross-sections (plates 8–11) effectively pull together the tectonic similarities between the Ouachita and Marathon belts, as does the tectonic synthesis chapter. The Epilogue provides a nice summary of problems that need to be addressed in the Ouachitas. One such problem is the ‘southward vergence’ of folds on the south side of the culminations—it is clear from the descriptions that workers in the area have not attempted to look at these folds as ones whose asymmetry has been reversed by large amounts of simple shear (as described from the Alps by Ramsay and his coworkers), even though other parts of the same thrust sheets contain sheath folds which obviously imply considerable shearing.

One of the nicest features of the volume are the 12 plates—maps and cross-sections—which summarize some of the latest data available on

the Appalachian–Ouachita belts. Conspicuous by their absence are gravity and aeromagnetic maps of the Appalachians, and additional seismic sections (particularly COCORP data)—although these have been published elsewhere before, their inclusion would have made the volume more complete. The individual chapters provide very comprehensive reference lists which should be very useful to readers wishing to pursue further any of the topics covered in the volume.

There is generally a time-lag in editing and producing a volume that involves so many authors: as a result the book tends to be a little out of date even when it first comes out because the latest material cannot be included. Keeping this in mind, a book like this, whose primary function is to pull together available data, can still be very useful if it is carefully edited. Unfortunately, in this volume there are lapses in technical editing that take away from an otherwise good book: there are more than a few spelling errors in the text and on figures, occasionally insufficient information in figure captions, and references to features on figures that are either inadequately highlighted or entirely missing.

In spite of these minor shortcomings the book does an excellent job of pulling together the information available, and should serve as a useful reference volume for years to come. It could also serve as a textbook for upper level courses on the Appalachian–Ouachita mountain belts; given the prices of most text-books, this book (for its price) merits serious consideration. For geologists working in the Appalachian or Ouachita–Marathon belts it is a book well worth reading.

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### Scotland revisited

Craig, G. Y. (editor) 1991. *The Geology of Scotland* (3rd edn). Published by the Geological Society of London, U.K. Price £65 (hardback; ISBN 0 903317 63 X); £29 (paperback; ISBN 0 903317 64 8).

The *Geology of Scotland* was first published in 1965, a second edition followed 18 years later in 1983 and now we have a third edition. So why should all those who purchased the second edition want to spend another £29 on the new edition? Has the last 8 years seen significant developments in our understanding and interpretation of Scottish Geology?

At first sight the third edition seems only slightly different; the cover is a slightly darker shade of blue and the cover illustration has changed, with the Bass Rock replacing the more readily recognizable Suilven. However, inside the cover there are 120 more pages and the majority of the text has been fully revised and largely rewritten by a total of 19 contributors. The resulting volume is a detailed account of one of the most studied areas of the world, suitable for undergraduates, ‘expert’ amateurs and as stated in the publisher’s summary, is ‘an indispensable reference work for geologists worldwide’.

The contents pages are less informative than those of the earlier volumes, but the layout is very similar. After an introductory chapter by A. L. Harris, summarizing the growth and structure of Scotland, and highlighting some of the controversies and recent developments in our understanding of particularly the Caledonides, the chapters follow in chronological sequence. There is a new chapter on the Lewisian by R. G. Park. The Torridonian has most deservedly been separated from the Moine with new chapters by A. D. Stewart, and A. L. Harris and M. R. W. Johnson, respectively. The Dalradian is described by M. R. W. Johnson and followed by two chapters on the Lower Palaeozoic by E. K. Walton and G. J. H. Oliver. P. E. Brown’s chapter on Caledonian and Earlier Magmatism has nearly doubled in length. There then follow chapters on the Old Red Sandstone (W. Mykura), the Carboniferous and Carboniferous–Permian Igneous Rocks (E. H. Francis), the Permian and Triassic (J. P. B. Lovell), the Jurassic, Cretaceous and Tertiary (A. Hallam), Tertiary Igneous Activity (H. Emeleus), the Quaternary (G. S. Boulton, J. D. Peacock and D. Sutherland) and finally Economic Geology (R. Beveridge, S. Brown, M. Gallagher, and J. Merritt). There is a reference list at the end of each chapter, making the text an excellent source book. The index is also very useful.

My only criticisms must be directed at the illustrations and diagrams. Many of the photographs are duplicates of those in the second edition and have been poorly reproduced, some are so dark that the geology

can no longer be seen, for example Fig. 13.4 or 15.6. Many of the diagrams have been cloned from the earlier edition and other publications and they are sometimes inconsistent.

There are also a few discrepancies between the chapters which illustrate the speed at which our understanding of the geology of Scotland is progressing and the need for this third edition. Perhaps we should ask the authors to start preparing the fourth edition for the year 2000. The introductory chapter was written whilst the others were in proof and therefore highlights the problems of the time required to prepare such a book. For example, the fossil evidence for a Lower Cambrian Age for the uppermost Dalradian is shown to be less certain than as stated by Johnson in Chapter 5. The Ben Vurich Granite also retains its  $514 \pm 6$  Ma age in the main body of the text of chapter 5 but has a  $590 \pm 2$  Ma age in Chapter 1.

From the point of view of a structural geologist the book provides a useful review of the Caledonides. However, there is little information on the recent developments in our understanding of the structure of offshore Scotland.

Despite these small shortcomings the book is a much welcomed update and a worthy addition to any bookshelf.

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### Flow through rocks

Phillips, O. M. 1991. *Flow and Reactions in Permeable Rocks*. Cambridge University Press, Cambridge, U.K. Price £40, \$59.50 (hardback).

The aim of this book is to bring together a disparate set of treatments of fluid flow relevant to geology. Some of the treatments may be familiar to readers of hydrogeological literature but the author brings in many subjects and generally strives for a more rigorous approach than can usually be found in basic hydrogeological texts. The maths appears hard going but a little perseverance can be worth it.

Chapter 2 deals with the basic physical and chemical principles which the book is based on, starting with geometric considerations of porosity, moving on to consider equations for motion of fluid elements through a matrix and dispersal and diffusion of dissolved species in a fluid with a concentration gradient. Darcy's law and permeability are given a thorough treatment. The chapter finishes by considering balances of energy and dissolved species.

The next two chapters have the theme of general characteristics of flow, starting with flow patterns, stream functions, vorticity and boundary conditions. Some scaling problems are also discussed. Flow patterns around isolated cracks, inclusions and flow along long lenticular layers are next, with flow transients and diffusion-induced flow rounding off this section. Still under the broad heading of General Flow Characteristics, Chapter 4 continues with patterns of reactions considering the approach to equilibrium, isothermal reaction fronts, mixing zones and isotherm-following reactions. This last section, and two other sections in this chapter on mixing and reaction patterns from faults and fractures and enhancement and destruction of porosity, should certainly be considered reading for any structural geologist thinking about fluid flow.

Chapter 5 deals with instabilities in such situations as brine invasion and salinity stabilization. Classic Rayleigh-Darcy type instabilities are discussed with their relevance to geological convection as well as specialist topics such as the important petroleum industry problem of Saffman-Taylor instabilities when a fluid of different density and viscosity displaces an interstitial fluid.

Chapter 6 provides a detailed, concise coverage of pressure-driven flows, more generally covered in the hydrogeological literature, but here dealing with more geological examples such as basin-wide fluid flow and mineralization distribution. The book finishes with a chapter on thermal convection with interesting examples such as submerged banks, convection and diagenesis in sloping isolated permeable strata, reefs and dolomitization.

The text of this book is clear and concise and can be read without rigorously following the mathematics, though the maths should be comprehensible to anyone with higher-level maths. The geological applications are thought-provoking and more meaningful to the general geologist than those found in similar texts written for hydrogeologists or in specialist literature. This book will be useful to those seeking

to quantify fluid flow, but should be read by any structural geologist who is considering fluid flow through rocks/fractures/faults/basins. Its a good starting point to get lots of equations and ideas. Sadly, it may be a little too expensive for Ph.D. students whom it may benefit most, but labs and libraries should certainly have it on their shelves for reference.

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### Capturing discussion on video

*Basin Development and Petroleum Exploration*. Geofilms Video, in conjunction with the Geological Society of London. 43 minutes. £42.50.

Finding myself with a spare evening, I expressed a desire to a colleague to spend a carefree hour or two watching an entertaining video. Unwise to be so unreserved, unguarded, unsuspecting, I was immediately presented with a copy of *Basin Development and Petroleum Exploration* and asked to provide critical comment.

Several moons and viewings later, I find myself still enquiring, "What message does this video champion?" and "For whom is it intended?" The cover informs us that it is "a record of the 1989 William Smith Lecture Meeting on Basin Development and Petroleum Exploration, and is designed to be the centre of discussion on this subject". Viewers expecting carefully edited highlights and action replays of the most revealing science and stimulating moments of the meeting will be desperately disappointed. In fact, the video consists of interviews with seven of the conference speakers that are linked by a rambling narrative from Dr Andrew Mackenzie.

The film fails with distinction. It lacks a coherent theme, has a poorly balanced content, in places misleads and suffers from too many subplots and minutiae. It begins with an obscure, animated cartoon illustrating (I think) plate tectonics and basin evolution that at first, second and all subsequent viewings seems irrelevant, as well as poorly produced. Andrew Mackenzie appears windswept and intensely sincere before backdrops of the Wytch Farm oilfield, the Bridport Sands and undisclosed stormy beach locations in southern England (the latter affectionately referred to as the 'continental margin').

The basic structure of the film leads me to assume the producers have tried to emulate an Open University format, but appear to lack the degree of professionalism or experience required for such an undertaking. The interviews are poorly structured and full of clichés. How, for example, the Bridport Sands relate to footwall uplift or thrust belts is not clear, to me at least. Each of the speakers interviewed, although widely acknowledged experts in their own fields (none of which include acting, apparently), expound their stilted, camera-shy opinions. We are confounded with the axiom "sandstones will deposit in depositional lows", led to believe "all geologists suffer from well-bore myopia" and asked to ponder "is there a place to catch all that oil?". Too many of the interviews appear staged but unrehearsed, expert but amateurish and detailed but introspective. One speaker divides basins into three categories, and then deems this such an obvious fact that he omits to define the three categories. Another argues that geometric and kinematic models of hanging wall geometries offer a means of investigating the evolution of faults in sedimentary basins and "provide a template for interpreting seismic sections". Mostly incorrectly, as all the models were listric.

My most damning condemnation of the film, however, is of the myth the film tries to propagate concerning organic geochemistry. The narrator and two of the speakers try to convince us that organic geochemistry has found more oil in basins than we would have done without it, and that this is the key to successful petroleum exploration. Apparently it's time to return to our "molecular roots". Indeed, "Time for a molecular comeback". Thank goodness for the common sense of John Martin to point out the fundamental importance of advanced seismic techniques and improved seismic interpretation. Not forgetting, as no cynical explorationist would, the significance of the actual market price of the commodity we're all rooting for in the basin.

The text of frames that the film cover advises "are best seen by using the pause or still frame facility on your video recorder" are mostly unreadable. They contain too much information, much of which is not self explanatory, and appear to be copies of the speaker's original transparencies.