I read this book as a structural geologist interested in seismology as it applies to tectonics. I learned many interesting aspects of seismology from the book, but I did find it hard going in several places, forcing me to refer to Aki and Richards (*Quantitative Seismology,* published by W. H. Freeman, San Francisco, 1980) and Ruth Simon (*Earthquake Interpretation,* published by William Kaufmann, Los Altos, California, 1981) extensively. Gubbins lists these and other resources. In other words, the book by Gubbins does not stand alone; this should not be a problem in most university settings.

The book's title suggests that it includes somewhat more on plate tectonics than it actually does. There is nothing wrong with the plate tectonics chapter: it gives a good basic grounding, but only in the practical (finding the movement patterns of the Erratic, Beatific, Nasty and Joker's plates) does anything of interest develop (to me). Hot spots, apparent polar wandering and paleomagnetic pole determinations are geophysical aspects of plate tectonics of current interest, barely covered or not covered at all.

I enjoyed the book, and I am still working on the practical problems. Would I use it as text for a basic geophysics course? Probably not, unless the student could afford a comparable book covering magnetism, gravity and electricity in their 'geo-' forms. As a basic seismology text it would need backup by Aki & Richards (1980) or Bullen & Bolt (1985). It does have practical information and procedures in seismology not easily found elsewhere; the practical exercises are valuable. The paperback price is quite reasonable (for the 1990s), and the blue and red cover map is handsome; a final challenge to the reader is to explain the two colors of fault solutions on the cover map.

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Petroleum basins at passive margins

Edwards, J. D. and Santogrossi, P. A. (editors) 1990. *Divergent/Passive Margin Basins.* American Association of Petroleum Geologists Memoir 48. The American Association of Petroleum Geologists, Tulsa, Oklahoma, U.S.A. Price $102 hardcover. AAPG members $68.

This Memoir is the third in a planned series of five volumes which together comprise AAPG's World Petroleum Basins project (Cratonic Basins; Interior Rift Basins; Divergent/Passive Margin Basins; Active Margin Basins; Foreland Basins and Foldbelts). The stated aim was to aid explorationists by supplying "a broad, comparable base of data and concepts to improve their forecasts through analogue techniques"; to provide usable analogues for frontier basins, not just descriptions for posterity. I have reviewed it in this context; but feel bound to emphasize the special nature of the volume, to pre-empt any disappointment by readers expecting a follow-up to the excellent Continental Margin Memoirs 29 and 34.

Memoirs 29 and 34 (and other well-known AAPG and SEPM products such as the Seismic Stratigraphy Volumes 26 and 42) contained a large number of fairly short, state-of-the-art papers. There was something for everyone, and the less dedicated reader could dip into the book and get a flavour of recent and current advances. In contrast, Memoir 48 contains four review papers on individual basins: the Campos (Brazil), the Northwest Shelf of Australia, the Gabon Basin and the Niger Delta. These range in length from less than 40 to more than 80 pages, and are augmented by short introductory and concluding sections by the editors. Apart from some good-quality seismic and geological cross-sections, there is little here for the casual reader—a significant investment of time is required to get much out of the volume.

In fairness to the series editors this is exactly what they set out to do—to describe in detail a few carefully selected 'type' or 'model' basins. The recent entry of smaller and independent oil companies (American not stated, but implied) into international exploration is cited as one reason for the timeliness of this series.

The editors' Introduction is very short (2 pages) and contains nothing which readers of this Journal will find new or surprising. Although they permit themselves more space in the Summary and Conclusions, I feel that the Introduction could usefully have been extended, especially as the chapter authors display some inconsistency in terminology.

The Campos Basin, described by L. R. Guardo, L.A.P. Gamboa and C. F. Lucchesi of Petrobras, seems to have been selected as 'the' model basin and justifiably so. It was on everyone's lips following Petrobras' deep-water successes and has provided encouragement elsewhere, particularly in West Africa. It would have been easy to choose the shallow-water Niger or Mississippi Delta, but perhaps somewhat backward-looking as few such plays remain unexplored.

The authors begin with a straightforward geological description of the basin, which displays a classic three-fold rift-to-passive-margin evolution. Non-marine syn-rift sediments of Early Cretaceous age are succeeded by an Aptian evaporite sequence associated with the transition to drifting. Drifting continued to the present day, allowing development of an open marine shelf which evolved from carbonate-dominated in the Late Cretaceous to clastic-dominated in the Tertiary. Of particular interest is the prolific syn-rift lacustrine source rock which has fed reservoirs of all ages: I suspect that most explorers would express initial scepticism over its regional charging capabilities. Reservoirs are typically turbidite fans associated with sea-level low-stands and range from Cretaceous to Oligocene in age. Giant fields are developed with turbiditic sands up to 150 m thick. The chapter concludes with descriptions of half-a-dozen fields with contrasting reservoirs: Badejo (Cretaceous, lacustrine coquina); Pampo (neritic Albian carbonates); Namorodo (Cenomanian/Turonian turbidite sandstones; Enchovas/Bonita (Eocene turbidites); Marlim (Palaeogene basin-floor fans with a component of stratigraphic trapping).

This chapter is a good summary, both for explorers and for land-biased structural geologists who wish to know what a passive margin is really like. It includes some very nice seismic sections (the best in the book), although unfortunately no uninterpreted versions are provided. However, the structural geological content is minimal and the geodynamic treatment unsophisticated—for example, backstripping or decompaction of the sediments is not touched upon and neither is McKenzie's model nor its successors. Salt tectonics scarcely rates a mention, despite its importance in generating many of the known hydrocarbon traps. The source reference list dates to about 1988, and includes many in Portuguese or in publications which would not appear in the average oil company library. It is certainly the most accessible treatment of the Campos Basin I have come across.

The next chapter on the Northwest Shelf of Australia (principally the Barrow-Dampier Basin) is much shorter at 35 pages. It is written by B. P. Butcher of Woodside Petroleum, operators of the Goodwyn–Rankin liquefied natural gas project. The author admits at the outset that much of what he writes has been superseded since the paper was prepared in 1985. In particular, a major conference volume was published in 1988 (Purcell, P. G. & Purcell, R. R. (editors), *The Northwest Shelf, Australia: Proceedings of the Petroleum Society of Australia Symposium,* Perth, 651 pp.). I know memoirs take a long time to get from manuscript to public, but it is a pity that the opportunity was not taken to incorporate the salient points arising from this symposium, or at least to point out if any of Butcher's conclusions have proven to be in error.

In contrast to the Campos Basin (but like the North Sea, for example), syn-rift, Early to Mid-Jurassic sediments were largely marine. The Callovian breakup unconformity outlines a pronounced end-rift topography which was infilled by fine-grained marine clastics of the early post-rift. Several largely descriptive pages are devoted to 15 later unconformities and disconformities of supposed eustatic origin. During the Tertiary the passive margin evolved into a broad carbonate shelf. Play types are straightforward: fluvio-deltaic Triassic sands within horsts and extensional tilted fault-blocks were sourced from interbedded or downthrown pre- and syn-rift coals and shales. Around 7 TCF of gas-condensate has been found in the Goodwyn–Rankin trend. Smaller, Jurassic discoveries also occupy structural traps.

Throughout this chapter, coverage of tectonics and structure is very sketchy and simplistic, and the lack of large-scale seismic sections does not help the reader to draw his own conclusions. A couple of other thoughts struck me in comparing this account with other basins and more recent publications: why are substantial Jurassic sandy turbidites not reported, when the tilted fault-blocks contained sandy Triassic sediments ripe for recycling; and what caused the unconformities—eustatic changes or flexural responses to sediment loading or in-plate stress?

The next chapter, on Gabon, occupies 83 pages and so appears to break the series editors' rule of having only one 'type' basin and several shorter accounts per volume. Although it contains no large-format seismic sections, full-page figures make up about half the content. Written by P. Teisserenc and J. Villemin of Elf, it is a very full and thorough description (in excellent English!) of the onshore and offshore Gabon Basin. It makes an interesting counterpoint to the Campos Basin on the other side of the South Atlantic.

As in the Campos Basin, syn-rift sediments (Neocomian to Barremian) are non-marine and intracontinental. Lacustrine shales reach a maximum thickness of 1000 m. The succeeding Melania Formation is very variable and develops fault-controlled facies including coarse turbidite fans. Syn-rift structures are draped by the post-rift Upper Melania black shale, a varved, lacustrine deposit 200–600 m thick. Despite a very different environment of deposition, the analogy with the Ryazanian Kimmeridge Clay of the North Sea is striking. A major deltaic system prograded into the lake during the Lower Cretaceous and initial influx of Atlantic waters is marked by the Upper Aptian Ezanga Salt.

Subsequently, Gabon lay on a muddy, open marine shelf; turbiditic and shelfal sands are known from the Cenomanian, Senonian and Palaeocene. Two major unconformities cut into the shelf: the first (Coniacian–Santonian) is attributed to epeirogenic uplift; the second (Early-Mid Miocene) to a eustatic cause. Miocene to Recent sediments are represented by a prograding delta–slope system. Halokinesis has played a major role in the structural development of the Gabon basin; movement began in the Albian but peaked in the Late Cretaceous, and affects the whole basin including the shallow shelf. A much wider range of structures appears to be displayed than in the Campos Basin—diapirs, turtles, pillows, dissolved diapirs, 'prismatic diapirs' (=rollers; interesting for their landward-dipping listric faults).

The basin contains total reserves of about 1.8 billion barrels. The authors provide a useful breakdown of field size and number by trap type and reservoir; the majority are simple turtle and dome–anticline traps, reservoired in Senonian turbidites. Pre-salt fields are principally reservoired in the immediately underlying Gamba Sandstone, in 'pre-salt anticlines'. In virtually all cases the source rock is believed to be the prolific Melania Shale.

As befits a 'type example', the basin appears to be thoroughly explored, although the authors mention the potential for Palaeogene deep-water exploration, economics permitting. Common-sense says that the sediment eroded from the shelf must have gone somewhere! There are also several mentions, but no descriptions, of the 'recent Rabi-Kounga discoveries'.

The final 'basin', the Niger Delta, is described by H. Doust and E. Omatsola of Shell. I use quotation marks because this is really a description of a delta rather than a complete passive margin—the sub-delta geology is essentially unknown so we have a gap which extends virtually from craton to oceanic crust. I must say I found this 38-page chapter somewhat disappointing—much of the data has been published before, also by Shell geologists, and even the figures look the same. Some of the ideas and interpretations are new, and perhaps that is all we can hope for when an author is asked to review a basin which has already been thoroughly reviewed and where little new information is available (at least, for public consumption). The authors launch very quickly (page 3) into the sedimentology and stratigraphy of the delta. Deltaic sediments are up to 12 km thick and range in age from Eocene to Recent. The delta is traditionally described in terms of 'depobelts', coast-parallel basins bounded by listric normal faults, within each of which a major regressive cycle of about 5–10 Ma duration was deposited. Successive depobelts step outwards as the preceding one ceases to subside and is overstepped by the delta-top. The authors attribute this pattern to the progressive (rather, intermittent) squeezing seaward due to sediment loading of under-compacted marine shales.

Oil and gas systems within the delta are facies- rather than age-controlled. Abundant sand reservoirs are developed in the paralic–continental targets pursued to date. Turbidite sands might also be expected in deep water (cf. the Mississippi delta) but have not yet been explored for. The light, waxy oil is linked to a deltaic (coastal plain, swamp) source, although the organic material which survived to generate crude oil was probably washed into slope or basin floor muds. Traps are typically structural (rollover anticlines, footwall closures, downthrown closures with cross-fault seal), but stratigraphic traps are also known (truncation of sands by muddy channel fill; regional sand pinchouts). A very large, loose enclosure includes a number of large-scale (although, unfortunately, neither deep nor regional) seismic sections.

The editors conclude the volume with a 10-page Summary and Conclusions—half text, half tables. They begin by pointing out the importance of passive margins—they form 60% of present continental boundaries—and their unique age characteristics (all are younger than Triassic, at least as far as drifting is concerned). Like the Introduction, this chapter is a nice, modern summary, but says nothing new to anyone who has been actively involved in extensional tectonics or passive-margin stratigraphy during the last 20 years. However, that is not the principal target audience for this book. I am particularly pleased that they, and the chapter authors, recognize the transition/early drift stage as infilling dead rift topography. This is perhaps easier where the onset of drifting is confirmed by the independent evidence of magnetic stripes. The tendency remains, in some aborted rifts, to assume that stretching must have continued until the last (highest) fault-scarp was onlapped.

The final tables summarize the principal characteristics of the four basins covered in this volume: regional setting, stratigraphy, structure, source rocks and reservoirs. I would have added one on trap type. The book ends with a 4-page computer-format index. I have not tried to use it in detail, but at first glance it seems to consist principally of place, oilfield and formation names.

Is the book worth reading? I would say yes, if you want a grounding in the regional geology of passive margin basins, but do not expect much in the way of leading-edge academic research. For example, there is very little coverage of modern ideas in structural geology, basin modelling, hot-spot vs non-hot-spot rifting and seismic stratigraphy.

The book more-or-less meets the editors' objectives—the basins are well selected, and include the 'classic' sequence of continental syn-rift, salt then marine post-rift, as well as an example with marine syn-rift and one where a large delta swamps everything. It would have been nice to see a description of a successfully exploited carbonate passive margin (e.g. the Bombay High?).

Who should buy it? Oil company and academic libraries are presumably the main target. It must be said that a moderately diligent researcher could extract most of this information from the existing literature, but at a man-hour cost substantially greater than the cover price. Production values are first rate even by AAPG standards, with seismic sections reproduced at a sensible scale and liberal use of colour in figures and core photographs.

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