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BOOK REVIEWS

Gondwanaland revived and reconstructed

Veevers, J. J. and Powell, C. McA. (editors) 1994. *Permian–Triassic Pangean Basins and Foldbelts along the Panthalassan Margin of Gondwanaland.* Geol. Soc. Am. Memoir 184, Boulder, Colorado, U.S.A. 368 pp. ISBN 0–8137–1184–3. Price: $100 (hardback).

Revived interest in the Late Paleozoic–Early Mesozoic Pangea megacontinent is arousing increasing research activity on many fronts—global climates, Permian–Triassic stratigraphy and tectonics, continental reconstructions, faunal and floral distribution patterns, etc. This volume investigates the 12,500 km Gondwanaland segment of the Pangean margin, paying particular attention to foreland basin evolution and associated deformation of the supercontinent's margin with the Panthalassan ocean. It is dedicated to the genius of A. L. Du Toit and is a remarkable confirmation of the Samfrau Orogenic Zone and associated Gondwanide foredeep as recognised by Du Toit in 1937.

The book opens with a concise discussion of Panthalassan reconstructions by Powell and Li. The original Du Toit map is reproduced and a new set of tight-fitting mid-Paleozoic–mid-Mesozoic Gondwanaland maps is presented.

A voluminous and detailed chapter covering eastern Australia follows (Veevers, Conaghan and Powell). Comprising 160 pages, 51 figures and more than 500 references, the authors must be congratulated on this gargantuan effort. Numerous meticulously drawn maps portray geological development in 5 to 30 million year time slices; several time–space diagrams are also included. These form the data base for a synthesis which includes a series of detailed paleogeographic and paleotectonic reconstructions extending from northern Queensland to Tasmania. Although well-organised and thought-provoking, I found these reconstructions disappointingly fixest, particularly with respect to Paleozoic marine mafic volcanic rocks in southeastern Queensland. This is one of the few places along the Gondwanaland margin where interaction with Panthalassa might be expected, but no hints of this are shown in the rather conventional reconstructions.

The Permian–Triassic Transantarctic Basin is described by Collinson, Isbell, Elliot, Miller and Miller. Because of snow and ice cover, outcrop is less than 2% of the total area. Nevertheless a convincing case is presented for development of a foreland basin along the entire Panthalassa–Gondwanaland margin of Antarctica. Basin framework and sedimentary facies are well presented with a clear account of paleogeography. However some serious problems appear to remain. For example, although a fold–thrust belt is shown flanking the entire length (3500 km) of the East Antarctic craton, in reality it is only actually recognised in the Pensacola and Ellsworth Mountains segments, a relatively small part of the belt. Elsewhere, Transantarctic Basin sediments are undeformed. Although extrapolated beneath ice in Marie Byrd Land and the Ross Sea, there is no real evidence of a fold-thrust belt beyond the Ellsworth–Pensacola area, where indeed only folds (no thrusting) are shown in the cross-sections. Couple this with the fact that the source of volcanic detritus in the Permian Beacon rocks is interpreted as the Brook Street Volcanic Arc: In the early Permian this arc was of fully oceanic nature and although described in the text as 'nearby', the across-strike distance between the arc and Beacon outcrops shown on the reconstructions is nearly 1000 km.

A chapter on southern Africa presents the evolution of the Carboniferous–Jurassic Karoo Basin. This is classic foreland basin architecture and is presented in a detailed and clear account by Veevers, Cole and Cowan. The craton, foredeep and orogenic belt are all well developed and it is not difficult to see how Du Toit's ideas developed from South Africa as a starting point. Sediment facies and dispersal patterns are explained and the well known Gondwanaland glacial deposits put into context. Unfortunately, the stratigraphic basis for basin development is presented in highly stylised angular columns which are not easy to interrelate. A sequence of neatly presented paleotectonic/geographic maps summarises the chapter effectively. It is interesting to see how effectively the Falklands fit the regional picture when reconstructed to lie east of the Cape. A hypothetical offshore Permian–Triassic volcanic arc, although required, is shown in a rather fanciful manner.

Chapter 6 covers southern South America. Written by Lopez-Gamundi, Espejo, Conaghan and Powell, this is a crisp and engaging chapter which is clearly illustrated. By this time, the reader is (correctly) anticipating the basin structure, provenance and paleogeographic setting—a reflection on the reality of this enormous foreland basin. Integration of good stratigraphic columns and sandstone petrography with the text is effective and helpful.

The seventh chapter, *Synthesis*, draws the strings together, produces some thought-provoking generalisations, and includes a one-page summary of New Zealand geology. The highlights lie in Gondwanaland-wide synchroneity in sedimentary events. Recognition of widespread glacial episodes is reinforced and in addition we find remarkable linkages between periods of tuff and coal deposition and also complementary contemporaneous 'tuff gaps' and 'coal gaps'. The abrupt inter-regional incoming of red beds at the Permian–Triassic boundary is also striking. Unfortunately the book ends rather abruptly, never really analysing the structure of this spectacular foreland basin complex.

Overall, this memoir rates as a substantial piece of work providing regional detail, good overviews and ideas for future work. Its main shortcoming lies in the lack of discussion of location and nature of the actual Gondwanaland–Panthalassan margin as stated in the title. In a study of this scope, relations in southeastern Queensland, New Caledonia and especially New Zealand should have been addressed much more fully. Here we find shallow marine and truly oceanic sequences, accretionary prisms, island arcs and arc-flanking basins of Permian–Jurassic age.

Otago, New Zealand — *Chuck Landis*

Two Special Papers from the Wild West

Seismotectonics of the Central California Coast Ranges. Alterman, I. B., McMullen, R. B., Cluff, L. S. & Slemmons, D. B. (editors) 1994. Geol. Soc. Am. Spec. Paper **292**. Price: $67 (soft back; ISBN: 0–8137–2292–6).

This volume arose from a series of papers at the 1987 GSA Symposium on the Seismotectonics of the Central California Coastal Ranges held in Hawaii (life is tough!). The symposium was convened in conjunction with the U.S. Geological Survey, the Nuclear Regulatory Commission and a number of academic institutions to fill a perceived gap in knowledge concerning the seismotectonics of the Californian plate boundary in this area; the scene was set by constructions such as the Diablo Canyon Power Plant. Although the plate tectonic setting of the area was at that time relatively well-known, the San Andreas discrepancy—that is, the shortfall in plate motion described by existing geological data compared to that described by the geodetic determinations using the Nuvel-1 satellite—pointed an accusing finger at the structures within the Central California Coastal Ranges as potential locations for the missing displacement and hence as potential sources for the release of significant amounts of seismic energy. This volume provides important new knowledge of fault activity in the Quaternary–Holocene for the accused region, providing a better understanding of potentially hazardous seismogenic sources and the kinematics of the plate boundary.

Amongst the 12 included papers is information on the tectonic setting of the offshore and onshore Santa Maria Basin, the San Simeon/Hosgri fault system, and the distribution and nature of seismicity within the region. You will find offshore seismic data provided by Steritz & Luyendyk and Cummings & Johnson, information about correlating marine terraces by Rockwell *et al.*, so-called stress determinations from fault-slip data by Vittori *et al.*, and an investigation of the seismicity by Dehlinger & Bolt. My personal favourites include a review of the seismotectonic framework by Clark *et al.*, and several excellent papers on using marine terraces and other geomorphic/stratigraphic features as strain gauges (e.g. Hanson *et al.*, Lettis *et al.*, Nitchman & Slemmons, Hanson & Lettis, Hall *et al.*, and another Lettis *et al.*); these papers are accompanied by 5 excellent (and very large) geological maps included in envelopes at the front and back of the volume. The strain gauge data—which tells us about uplift/subsidence rates, fault-slip rates and earthquake recurrence intervals—show that some structures do appear to show deformation rates that agree with predictions of long-term deformation derived from space-based geodesy: others clearly do not and appear to be dead, but not gone.

This is exciting material! Despite the 1987 vintage of the work, and the concentration on geomorphic and Quaternary–Holocene stratigraphic data rather than structural geology, the information was a breath of fresh air to me, and provided insights into the growth of geological structures that many structural geologist may not be accustomed to. Through examination of deformed marine terraces and other geomorphic features, the authors provide real data on the rates of Quaternary–Holocene regional deformation and the growth of faults and folds: marvellous stuff!

Overall, I found most of this book to be gripping and very worthy of a place on the shelf of any structural geologist. I will proudly carry this one into the coffee room to astound my sedimentologist colleagues and those who work on the Quaternary; colleagues who may previously have thought that structural geologists only look at old and undeforming rocks.

Basins of the Rio Grande Rift: Structure, Stratigraphy and Tectonic Setting. Keller, G. R. and Cather, S. M. (editors) 1994. Geol. Soc. Am. Spec. Paper **291**. Price: $72.50 (soft back; ISBN: 0-8137-2291-8).

This volume arose from a series of papers presented at a symposium of the 1991 joint meeting of the Rocky Mountain and South-Central sections of the Geological Society of America. The volume highlights the view that the basins of the Rio Grande Rift are part of a late Cenozoic intra-continental rift which differs from the Kenya, Baikal and Rhine rifts in that (1) it is well-exposed due to incised modern drainage; (2) petroleum exploration has spawned a number of seismic reflection profiles; (3) the geology is constrained by a number of radiometric dates. The volume contains 19 papers and deals with all the basins comprising the rift, with coverage of the geology from Colorado, through New Mexico to Texas; an area of about 400,000 km^2: an extensive and welcome data-base indeed!

Although the volume concentrates on a single geographical area, it contains many sections that will be of interest to readers of this Journal. Chapin & Cather describe the tectonic setting of the whole rift. They suggest that rotation about a Euler Pole to the north of the rift explains both the increase in purported values of extension from north to south and the kinematics of so-called accommodation zones between individual sub-basins that appear to lie on small circles relative to the Euler Pole. A section on the 'accommodation zones' shows that their geometry and kinematics are poorly-constrained, a situation which may tempt structural geologists with an interest in such structures to get their boots on and go and have a look at them! Also, an intriguing section which investigates the rift's uplift history through studies of the palaeoelevations of flora preserved in Eocene Lake Beds should be of interest to geodynamicists with botanical interests. Seismic reflection profiles allowing speculation concerning the deep structure of the rift are provided in papers by Kluth & Schaftenaar, Russel & Snelson and Barrow & Keller. These speculations fuel the long-standing debate concerning the existence of listric normal fault geometries and low-angle detachments in rifts: some people can see them, some cannot! With the clear presentations of the actual seismic lines, the reader can join in and have a go at interpreting the enigmatic seismic data. Schneider & Keller and Adams & Keller use a variety of geophysical data to examine the lithospheric structure of the rift. Lewis & Baldridge use models of flexural deformation for the footwalls of rift-bounding faults to suggest that some contractional structures previously attributed to Laramide compression may have formed during the Cenozoic extension. Harrison examines the orientations of faults and stress axes for one basin within the rift. Beck & Chapin suggest that Proterozoic structural trends have been reactivated during the growth of Phanerozoic structures. Salyards *et al.* present palaeomagnetic data which show that the Rio Grande Rift is not rotating as a whole, as previously thought, but consists of a number of smaller counter-clockwise rotating blocks. Mack *et al.* use magnetostratigraphy to examine the stratigraphic variations across faults in the rift. May *et al.* present apatite fission-track data and show that rapid uplift occurs in the footwall of the rift-bounding faults whilst slower uplift occurs on the hanging-wall dip-slopes. Collins & Raney investigate Quaternary fault movements within the rift. The volume also contains many other sedimentological and stratigraphical data which will interest structural geologists who enjoy brief respites from deformed rocks!

Overall, a nice volume to have on the shelf, with many insights into the development of rift zones. I am sure those working around the Rio Grande, or those studying rifts will wish to own a copy of this volume, but I am sure many may simply wish to order it for their library.

The approach adopted in these two volumes from the Geological Society of America is that of applying old techniques to new rocks. This approach—an approach that is, in my view, not encouraged by funding constraints in my own country—appears to me to have produced some very exciting new results and important insights into fundamental earth processes. I am pleased that the Geological Society of America provides encouragement, in the form of such volumes, to workers engaged in basic data collection.

London, U.K. *Gerald P. Roberts*

Model collection

Modern Developments in Structural Interpretation, Validation and Modelling. Buchanan, P. G. & Nieuwland, D. A. (editors) 1996. Geol. Soc. Spec. Publ. **99**. Price: £70 (£36 for members of the Geological Society).

This Geological Society special publication provides a comprehensive review of the latest developments and techniques available in structural interpretation, cross-section validation and modelling techniques. The volume is of modest size (370 pages in length) containing 23 articles organised into six chapters on the basis of methods and techniques used. After an introduction, the chapters cover, in order: (1) Seismic Interpretation; (2) Palinspastic reconstruction and forward modelling; (3) Fault populations and geometric analyses; (4) Analogue modelling; (5) Mathematical modelling, and finally, (6) Regional analysis and remote sensing. It is inevitable, however, that there is a large degree of overlap between individual chapters and that most authors have combined more than one technique to achieve their goals. Most people, I feel, will dip into this volume (as I did) to concentrate on those chapters and techniques that are relevant to their interests rather than reading the entire volume from cover to cover.

This special publication begins with *Seismic Interpretation* (Chapter 1). In their excellent introduction, the editors point out that the single most important technique that has enabled significant advances in structural interpretation is 3D seismic. Access to 2D and 3D seismic for structural interpretation is becoming widely available in academia. It is appropriate that the first chapter of this Special Publication focuses on some of the pitfalls of using seismic interpretations for validating 3D fault geometries. The first contributor to Chapter 1 outlines the advantages of integrating gravity and magnetic data for validating seismic processing and interpretation. The next paper deals with estimating the density of faults below the limit of seismic resolution by analysing the fractal or power-law scaling of fault displacements. The last contributor in Chapter 1 focuses on quantifying the variety and complexity of ductile strain associated with faults. This paper provides a number of examples in which significant fault-related ductile strain can be demonstrated. These authors show that fault-related ductile strains can occur on all scales and can vary both laterally and vertically.

Chapter 2, *Palinspastic Reconstructions and Forward Modelling*, contains the largest number of contributors to this volume. The chapter