



GR focus review

Middle–Late Paleozoic Australia–Asia convergence and tectonic extrusion of Australia



Chris Klootwijk *

Research School of Earth Sciences, The Australian National University, Australia

ARTICLE INFO

Article history:

Received 5 January 2012

Received in revised form 3 October 2012

Accepted 13 October 2012

Available online 8 November 2012

Keywords:

Alice Springs Orogeny

Central Asian Orogenic Belt

Kiaman

paleomagnetism

tectonic extrusion

Variscan Orogeny

ABSTRACT

Recent and new paleomagnetic data from ignimbrite-rich Carboniferous successions of the western Tamworth Belt, Southern New England Orogen, eastern Australia, show a northward excursion over $\sim 30^\circ$. Paleozoic data from the Australian craton and Tasman Orogenic System (TOS) suggest an Early Devonian start. At the middle-late Visean peak, the central New Guinean promontory of the Australian craton reached 30° – 40° N, within the latitude range of the western Central Asian Orogenic Belt (CAOB). Devonian–Carboniferous convergence of Australia/northeastern Gondwana with the CAOB, across the Paleoasian–Rheic Ocean, is proposed as a major driver for contemporaneous tectonism throughout Australia and the CAOB. This implies a substantial Variscan, Pangea-forming, influence on Australian Devonian–Carboniferous tectonics – Alice Springs Orogeny (ASO) and Quilpie and Kanimblan Orogenies. Convergence-related compressional deformation of Australia is largely confined to a “compression box”, extending southward from the New Guinean promontory and bounded westward by the Lasseret Shear Zone and eastward by the East Australian Rift System. Comparable characteristics of Paleozoic Australia–Asia and Cenozoic India–Asia convergence – north–south compression, weak and heated crust (Larapintine Graben and TOS/Tibetan Plateau), eastern “free oceanic boundary” (Paleopacific/Pacific) – do link Paleozoic Australia–Asia convergence to Cenozoic tectonic extrusion of Tibet. Tectonic extrusion of ductile lower crust from the Larapintine Graben led to eastward displacement of the Thomson and Northern New England Orogens, with upper crustal displacement bounded northward by Arunta Block shear zones, the Diamantina River Lineament, the Clarke River Fault Zone and the Townsville Trough, and southward by the Darling River/Cobar–Inglewood Lineaments and Cato Fracture Zone with the Lake Blanche–Olepoloko Fault Zones and Lachlan Transverse Zone as a subsidiary. Recognition of ASO-related tectonic extrusion opens novel, provocative, insights into puzzling aspects of Australian Middle–Late Paleozoic evolution.

© 2012 International Association for Gondwana Research. Published by Elsevier B.V. All rights reserved.

Contents

1.	Introduction	6
1.1.	Alice Springs Orogeny – an orogeny in search of a cause	6
1.2.	Unconventional leads	6
2.	Convergence across the Paleoasian–Rheic ocean	7
2.1.	An eastward open “Paleotethys” before Late Carboniferous?	7
2.2.	Contemporaneous tectonism in southern Laurasia and northeastern Gondwana	7
2.2.1.	Southern Laurasia	7
2.2.2.	Eastern Gondwana	8
2.2.3.	Widespread eastern Pangean tectonism incompatible with eastward open ocean	8
2.3.	Paleomagnetic control on Australia–Asia convergence	9
2.3.1.	Carboniferous paleomagnetism of the Southern New England Orogen (SNEO)	9
2.3.2.	Middle–Late Paleozoic paleolatitudinal evolution of Australia	10
2.3.3.	Carboniferous paleolatitudinal evolution of the New Guinean cratonic promontory	11
2.3.4.	Central Asian Orogenic Belt concepts and paleolatitudinal control	12
2.4.	Paleoasian–Rheic Ocean and Paleotethys concepts	13
3.	Convergence across the Neotethys	17
3.1.	Cenozoic India–Asia collision and Paleozoic Australia–Asia tectonics	17
3.2.	Cenozoic indentation and tectonic extrusion of Eurasia	19

* Research School of Earth Sciences, The Australian National University, 47 Daley Road, Acton ACT 0200, Australia. Tel.: +61 2 6125 3241; fax: +61 2 6125 5544.

E-mail address: chris.klootwijk@anu.edu.au.

3.2.1.	Gondwanan indenters	19
3.2.2.	Upper crustal movements	20
3.2.3.	Lower crustal/uppermost lithospheric mantle movements	20
3.3.	What drives evolution of the Tibetan Plateau?	21
3.4.	Continuum versus localized deformation	22
3.5.	Tibetan lower crustal ductile flow processes	23
4.	Alice Springs Orogeny and tectonic extrusion	24
4.1.	Observational limitations	24
4.2.	Tectonic extrusion – key elements	25
4.2.1.	Formation of the Larapintine Graben	25
4.2.2.	Heat accumulation within the Larapintine Graben	27
4.2.3.	Substrate of the Tasman Orogenic System	27
4.2.4.	Compressional deformation confined within “compression box”	27
4.3.	Tectonic extrusion model	29
4.3.1.	Applicability	29
4.3.2.	Outline of the ASO-related tectonic extrusion model	29
4.4.	Supporting observations	30
4.4.1.	Lower crustal evidence	30
4.4.2.	Upper crustal evidence	32
4.4.3.	Classic Eromanga–Brisbane seismic profile revisited	33
4.4.4.	Fold draping onto the Nebine Ridge and Anakie Inlier	34
4.4.5.	Hydraulic connectivity and tectonic synchronicity	34
4.5.	Implications	35
4.5.1.	Post-tectonic extrusion – Kiaman – deep crustal remagnetization	35
4.5.2.	ASO-related paleomagnetic overprinting	35
4.5.3.	Centralian gravity anomalies and crustal stress	36
4.5.4.	Namurian lacunae and Kanimblan Highlands	36
4.5.5.	Geothermal energy potential	37
4.5.6.	Development of SNEO oroclinal	38
5.	Discussion	39
6.	Concluding remarks	40
6.1.	Sources of inspiration	40
6.2.	Main premises of the ASO Tectonic Extrusion Hypothesis	40
6.3.	New insights into Australia’s Middle–Late Paleozoic tectonic evolution	40
	Acknowledgments	41
	References	41
	Glossary	53

1. Introduction

1.1. Alice Springs Orogeny – an orogeny in search of a cause

The cause of the Alice Springs Orogeny (ASO) is unclear, as summarized by Coney et al. (1990, p 537): “It obviously records a massive intraplate failure of the Australian craton. In a broad sense the Alice Springs orogeny is coeval with the mid-Carboniferous Kanimblan late compressive events in the Lachlan,..... To date, no plate tectonic explanation for the Alice Springs orogeny has been recognized.”

Australia’s Paleozoic tectonic evolution is generally interpreted in a Paleopacific subduction framework. A westward subduction driver however, does not relate naturally to the north–south stress pattern of the ASO. Alternative exploration of a southward, Tethyan tectonic, driver for the ASO has been hold back by prominent presence on Paleozoic global reconstructions of an eastward open ocean between northeastern Gondwana and southeastern Laurasia. Implications from recent paleomagnetic data from eastern Australia however, do question the reality of such an eastward open ocean during Early Carboniferous in particular. The new data define a substantial and mainly Early Carboniferous northward movement of Australia/northeastern Gondwana, leading to collision with the Central Asian Orogenic Belt (CAOB). Such convergence offers a wanting Tethyan driver for the ASO and, in turn, offers a conceptual stepping stone for re-interpreting Australian Middle–Late Paleozoic tectonics as driven, at least partly, by ASO-related tectonic extrusion. Such re-interpretation is attempted herein, building on new concepts for lower crustal ductile flow that are emerging from study of tectonic extrusion of the Tibetan Plateau by the India–Asia collision – arguably the world’s most spectacular example of Tethyan-driven intra-cratonic deformation, quite maturely developed yet actively progressing before

our eyes, and attracting a broad range of “hot” studies that are sourcing new, fundamental, concepts.

1.2. Unconventional leads

Powell (1984) recognized the widespread nature of Late Paleozoic north–south compressional deformation throughout Australia and attributed intra-cratonic ASO-related deformation and large-scale mega-kinking throughout the Tasman Orogenic System (TOS) to a common, though unidentified, mid-Carboniferous cause. The wide extent and pervasiveness of such deformation are well recognized nowadays (Williams and Pulford, 2008), exemplified by recent seismic profiling evidence for Early Carboniferous southward thrusting of the Thomson Orogen over the Lachlan Orogen at the Olepoloko Fault Zone (Glen et al., 2006) and Devonian? southward thrusting at the northern Selwyn Block (Cayley et al., 2011). This emerging picture of Australia-wide north–south compressional deformation however, is hard to reconcile with the plate tectonic paradigm of westward, head-on or even highly oblique, Paleopacific subduction as the main driver for Paleozoic deformation of the TOS and the Australian craton (Gray and Foster, 2004).

Several unconventional, directionally more comfortable, tectonic scenarios do invoke Tethyan, rather than Pacific, drivers featuring northward convergence and collision of Gondwana with Laurasia. Veevers (1994) and Veevers et al. (1994a) linked Late Paleozoic deformation of Australia and mid-Carboniferous uplift of the Gamburtsev Subglacial Mountains of central Antarctica to the well-established, but distant, Pangea-forming collision of northwestern Gondwana with southwestern Laurasia. In contrast, Klootwijk (1995, 1996a) attributed the ASO to convergence of Australia, as part of northeastern Gondwana,

Download English Version:

<https://daneshyari.com/en/article/4727027>

Download Persian Version:

<https://daneshyari.com/article/4727027>

[Daneshyari.com](https://daneshyari.com)