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

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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 ~30°. 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 Lasseter 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.

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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,