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Structural inversion of the Tamworth Belt: Insights into the development of orogenic curvature in the southern New England Orogen, Australia

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ABSTRACT

The middle to late Permian Hunter Bowen Event is credited with the development of orogenic curvature in the southern New England Orogen, yet contention surrounds the structural dynamics responsible for the development of this curvature. Debate is largely centred on the roles of orogen parallel strike-slip and orogen normal extension and contraction to explain the development of curvature. To evaluate the dynamic history of the Hunter Bowen Event, we present new kinematic reconstructions of the Tamworth Belt. The Tamworth Belt formed as a Carboniferous forearc basin and was subsequently inverted during the Hunter Bowen Event. Kinematic reconstructions of the Tamworth Belt are based on new maps and cross-sections built from a synthesis of best-available mapping, chronostratigraphic data and new interpretations of depth-converted seismic data. The following conclusions are made from our study: (i) the Hunter Bowen Event was dominantly driven by margin normal contraction (east–west shortening; present-day coordinates), and; (ii) variations in structural style along the strike of the Tamworth Belt can be explained by orthogonal vs. oblique inversion, which reflects the angular relationship between the principal shortening vector and continental-arc margin. Given these conclusions, we suggest that curvature around the controversial Manning Bend was influenced by the presence of primary curvature in the continental margin, and that the Hastings Block was translated along a sinistral strike-slip fault system that formed along this oblique (with respect to the regional east–west extension and convergence direction) part of the margin. Given the available temporal data, the translation of the Hastings Block took place in the Early Permian (Asselian) and therefore preceded the Hunter Bowen Event. Accordingly, we suggest that the Hunter Bowen Event was dominantly associated with enhancing curvature that was either primary in origin, or associated with fault block translation during the Early Permian. This model differs to previously proposed reconstructions where curvature largely formed by orogen parallel strike-slip transportation during the Hunter Bowen Event.

1. Introduction

The Tasmanides of the Australian continent comprise a collage of Cambrian–Cretaceous orogenic belts that formed in response to convergent margin tectonism (Fig. 1a; Glen, 2005). Although the Tasmanides were initially thought to consist of three broadly linear north–south striking orogenic belts (i.e., Delamerian, Lachlan and New England orogens), recent structural and geophysical studies have revealed the presence of macro-scale bends that contort these orogens into a number of oroclines (Fig. 1a; Musgrave, 2015). While the presence of orogenic curvature in the Tasmanides is becoming increasingly apparent, the mechanism(s) responsible for the development of this curvature is not as clear. This is particularly the case in the southern New England Orogen where orogenic curvature is widely acknowledged, yet hotly debated as to the number of bends, the timing that curvature was acquired and the underlying dynamic mechanism responsible (Offler and Foster, 2008; Cawood et al., 2011a; Rosenbaum et al., 2012; Li et al., 2012; Li and Rosenbaum, 2014; Offler et al., 2014). A central theme of this

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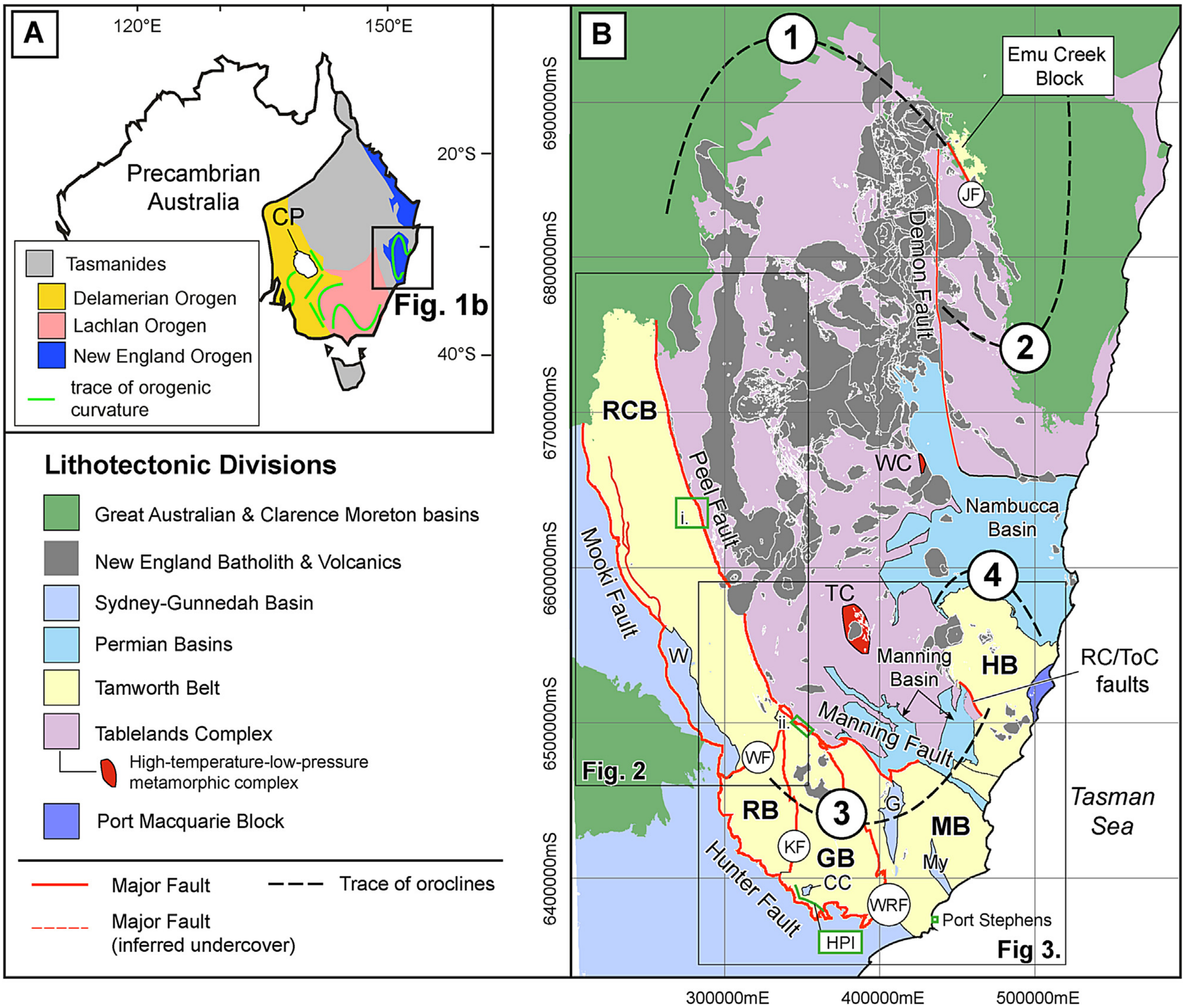

Fig. 1. Locality map of the Tasmanides and the southern New England Orogen. (a) Spatial distribution of the Tasmanides and the New England Orogen of eastern Australia. The postulated traces of orogenic curvature are taken from Musgrave (2015). Abbreviation: CP: Curnamona Province. (b) Simplified geological map of the southern New England Orogen showing the distribution of the main lithotectonic elements shown in the legends. The trace of the four postulated bends is shown as a thick dashed line: (1) Texas; (2) Coffs Harbour; (3) Manning, and (4) Hastings. Lithotectonic elements shown in legends are as follows: (i) Great Australian and Clarence Moreton Basin: Jurassic–Cretaceous intracratonic depocentres dominated by fluvial and minor marine sedimentary successions; (ii) New England Batholith and Volcanics: Permian–Triassic igneous rocks dominated by felsic plutonics with subordinate volcanics; (iii) Sydney and Gunnedah Basin: Permian–Triassic depocentre with a transitional deposition history ranging from early marine to fluvial; (iv) Permian Basins: Early Permian fluvial deposition; (v) Tamworth Belt: Carboniferous upper plate forearc depocentre dominated by arc derived detritus; (vi) Tablelands Complex: Silurian–Carboniferous lower plate accretionary accumulations; (vii) Port Macquarie Block: Palaeozoic low-grade rocks comprising local occurrences of high-pressure metamorphic rocks. The extent of maps shown in Figs. 2 and 3 are shown as rectangles. Note that specific locations discussed in the text are shown in the following frames: (i) Manilla area of Cao and Durney (1993); (ii) Glenrock Station area after Offler and Williams (1987). Fault block abbreviations: RCB: Rocky Creek Block; RB: Rouchel Block; GB: Gresford Block; MB: Myall Block; HB: Hastings Block. Fault abbreviations: JF: Jump-Up Fault; KF: Karakurra Fault; RC/ToC: Raffles Creek/Toms Creek faults; WF: Waverley Fault; WRF: Williams River Fault. Basin abbreviations: CC: Cranky Corner Basin; G: Gloucester Basin; My: Myall Basin; W: Werrie Basin. Miscellaneous abbreviations: WC: Wongwibinda Complex; TC: Tia Complex; HPI: Hudson Peak Ignimbrite. Map Projection is Geocentric Datum of Australia 1994, Zone 56.

debate is the role(s) of orogen parallel and orogen normal deformations in developing curvature. Supporters of the orogen parallel deformation model propose that oblique transpression (with respect to the initial north–south orientation of the orogen) was responsible for the buckling of the orogen around north–south striking axes (Offler and Foster, 2008; Cawood et al., 2011a). Of these workers, Offler and Foster (2008) suggest that dextral transpression was responsible for the development of the northern Texas and Coffs Harbour bends (Fig. 1b), while Cawood et al. (2011a) argue that sinistral transpression was responsible for the formation of the Texas and Coffs Harbour bends, as well as the more controversial Manning and Hastings bends in the south (Fig. 1b). In contrast to these models, supporters of the orogen normal deformation model invoke extension and contraction cycles as the main driver responsible for orogenic curvature (Rosenbaum et al., 2012; Li et al., 2012; Li and Rosenbaum, 2014; Shaanan et al., 2015). This model is comparable to that proposed for the western Mediterranean region, where along strike variations in the rate of subduction zone rollback leads to heterogeneous extension in the overriding plate, ultimately contorting a linear orogen into a complex arcuate geometry (Rosenbaum and Lister, 2004).

Kinematic reconstructions of the southern New England Orogen during the development of orogenic curvature are required to test these contrasting models. In this paper, we present a new