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Linking Observations of Dynamic Topography from Oceanic and Continental Realms around Australia

K. Czarnota (1,2), M. J. Hoggard (1), N. White (1), and J. Winterbourne (1)

(1) Bullard Laboratories, Department of Earth Sciences, University of Cambridge, CB3 0EZ, UK, (2) Geoscience Australia, GPO Box 378, Canberra, ACT, 2601, Australia (karol.czarnota@ga.gov.au)

In the last decade, there has been growing interest in predicting the spatial and temporal evolution of dynamic topography (i.e. the surface manifestation of mantle convection). By directly measuring Neogene and Quaternary dynamic topography around Australia's passive margins we assess the veracity of these predictions and the interplay between mantle convection and plate motion. We mapped the present dynamic topography by carefully measuring residual topography of oceanic lithosphere adjacent to passive margins. This map provides a reference with respect to which the relative record of vertical motions, preserved within the stratigraphic architecture of the margins, can be interpreted. We carefully constrained the temporal record of vertical motions along Australia's Northwest Shelf by backstripping Neogene carbonate clinoform rollover trajectories in order to minimise paleobathymetric errors. Elsewhere, we compile temporal constraints from published literature. Three principal insights emerge from our analysis. First, the present-day drawn-down residual topography of Australia, cannot be approximated by a regional tilt down towards the northeast, as previously hypothesised. The south-western and south-eastern corners of Australia are at negligible to slightly positive residual topography which slopes down towards Australia's northern margin and the Great Australian Bight. Secondly, the record of passive margin subsidence suggests drawdown across northern Australia commenced synchronously at 8 ± 2 Ma. The amplitude of this synchronous drawdown corresponds to the amplitude of oceanic residual topography, indicating northern Australia was at an unperturbed dynamic elevation until drawdown commenced. The synchronicity of this subsidence suggests that the Australian plate has not been affected by a southward propagating wave of drawdown, despite Australia's rapid northward motion towards the subduction realm in south-east Asia. In contrast, it appears the mantle anomaly responsible for this drawdown is a relatively young, long-wavelength feature. Thirdly, there is an apparent mismatch between the current drawdown of oceanic lithosphere observed along Australia's southern margin and the onshore record of Cenozoic uplift. This disparity we attribute to the region undergoing recent uplift from a position of dynamic drawdown.