Dynamic disequilibrium in Australia’s continental interior

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* **This abstract is for an Oral presentation**
* **Proposed Session: Tectonics**

# ABSTRACT

Australia is the flattest, most tectonically quiescent of all the continents. Slow erosion across Australia’s arid interior is testified by cosmogenic nuclide-derived denudation rates of 5 ± 2 m Myr–1 integrated over the past few hundred thousand years. The upshot of this slow denudation is a landscape that retains a long geomorphic memory with responses to perturbations that are characteristically subtle. And yet, paradoxically, Australia is also the fastest moving continent. Rapid plate motion towards the north-northeast is a significant source of tectonic stress that together with observations of landscape disequilibrium prompt the suggestion that the evolving *in situ* stress regime is preserved in the geomorphic record. For instance, a suite of observations across central Australia suggests topographic transience over 106–107 yr timescales: (1) endorheic drainage; (2) epigenetic bedrock gorges; and (3) a transcontinental band of anomalous sedimentary basins and river patterns aligned orthogonal to plate motion.

Our focus here is the existence of numerous endorheic basins flanking the western Lake Eyre Basin. These are topographic depressions containing a terminal playa underlain by basin fill. What do these basins reveal about the role of tectonic stress in the topographic evolution of central Australia?

To evaluate the stability of river catchments and their drainage divides we examine the distribution of channel steepness and the *χ* metric in the western Lake Eyre Basin and adjoining Lake Lewis basin—an area in which drainage patterns coincide with extreme gravity anomalies. We devise a set of numerical simulations that incorporate the flexural response to these gravity anomalies. The simulations demonstrate that temporal shifts in lithospheric rigidity can drive topographic changes in low-relief landscapes, including drainage capture and the development of endorheic basins, consistent with field observations.

We conclude that key aspects of the macro-scale geomorphology of Australia’s continental interior are less the result of the post-Miocene intensification of aridity and more the legacy of a fast-moving plate and associated interactions within and beneath the lithosphere.