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Geomorphic imprint of dynamic topography and intraplate tectonism in central Australia

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The mantle convection accompanying plate motion causes vertical movements of up to a few hundred metres at Earth's surface over wavelengths of 10^2 – 10^3 km. This *dynamic topography* appears to come and go at ~ 1–10 Myr timescales in areas that are often well away from plate margins, although its spatial and temporal characteristics are subject to ongoing debate. Since such motions are small and transient, discriminating convective signals from other drivers of relief generation and/or sediment dispersal remains tricky. An outstanding challenge is to detect these elusive, transient undulations from a tell-tale geomorphic imprint preserved in either drainage patterns or the stratigraphic record.

In the intra-plate setting of central Australia, a 30 km long sinuous gorge is developed where the major regional drainage, Finke River, dissects a band of low hills. Remarkably, this gorge is intertwined with an abandoned and less deeply incised gorge that forms hanging junctions and shares similar width and sinuosity. This unusual overprinting of the two gorges remains unexplained.

With an aim to investigate the history of the intertwined gorges, we measured cosmogenic ^{10}Be and ^{26}Al in fluvial gravels stored in the palaeovalley cutoffs. The gravels are remnants of major alluviation episodes that we surmise result from ongoing vertical motions associated with dynamic topography. We use a Markov chain Monte Carlo-based inversion model to test two hypotheses to explain the nuclide inventory contained within the stored fluvial gravels. In the first case, rapid alluviation and erosion since 1 Ma preserves the nuclide memory of the source area; in the second, the nuclide memory is erased during long-term fluvial storage (> 5 Myr) and is restored during exhumation of the palaeovalley gravel-pile. The two hypotheses are therefore limiting-case scenarios that constrain overall fast versus slow landscape evolution, respectively. Our model results suggest that long-term burial decouples the source-area signal from nuclide abundances

measured in the palaeovalley gravels. This casts events into a Miocene timescale.

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