EGU21-9165, updated on 02 Dec 2021
https://doi.org/10.5194/egusphere-egu21-9165
EGU General Assembly 2021

Geomorphic imprints of dynamic topography and intraplate tectonism in central Australia

John Jansen[1], Mike Sandiford[2], Toshiyuki Fujioka[3], Timothy Cohen[4], Martin Struck[5], Suzanne Anderson[6], Robert Anderson[6], and David Egholm[7]

[1]Czech Academy of Sciences, GFÚ Institute of Geophysics, Prague, Czechia (jdj@ig.cas.cz)
[2]School of Earth Sciences, University of Melbourne, Melbourne, Australia
[3]National Research Centre for Human Evolution (CENIEH), Burgos, Spain
[4]School of Earth, Atmospheric & Life Sciences, University of Wollongong, Wollongong, Australia
[5]Federal Waterways Engineering & Research Institute, Karlsruhe, Germany
[6]Department of Geological Sciences, University of Colorado, Boulder, USA
[7]Department of Geoscience, Aarhus University, Aarhus, Denmark

The Finke River in central Australia is counted among the world's oldest drainage systems, raising the prospect that it holds a geomorphic record relevant to testing ideas about the role of sub-lithospheric mantle flow in shaping the Australian landscape. The Finke's upper reaches preserve an enigmatic set of intertwined active and relict gorges that suggest a complex history of incision, aggradation and re-incision. We measured cosmogenic ^{10}Be and ^{26}Al in fluvial gravels stored in the gorges, and we applied a Markov chain Monte Carlo-based inversion model to test two limiting-case hypotheses about the timing of the gravel deposition and exhumation. Our results suggest that the nuclide memory contained within the gravels was essentially erased during protracted sediment storage. Previous studies attribute landscape evolution to the intensified post-Miocene aridity in tune with the perception that central Australia experienced limited deformation during the Cenozoic. However, the close correlation between drainage network patterns and the gravity field leads us to propose, instead, that incision/aggradation phases in the upper Finke are driven by a flexural response (at ~10^2 km length scales) to extreme uncompensated loads embedded in the crust. Further, we suggest that dynamic mantle processes have deformed the central Australian topography over longer (~10^3 km) wavelengths via the in-situ stress field, with horizontal stress variations of order 1–10 MPa. Acting together, these crustal and sub-lithospheric structures have imposed to-and-fro tilting on the Finke, triggering the phases of incision/aggradation on a million-year timescale that created the unusual intertwined bedrock gorges. The amplitude of topographic responses in the upper Finke to inferred variations in end-loading on the plate helps resolve an ongoing debate about the effective elastic thickness of the central Australian lithosphere to no more than 35 km.