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The influence of lithological variation in bedrock river evolution in post-orogenic intra-plate settings

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The role of lithological variation in the evolution of both steady-state and transient landscapes remains unresolved. Davis claimed a century ago that the role of lithology diminished throughout his Geographical Cycle, until it exerted no influence at all in 'mature' and 'old age' terrains, whereas Hack argued a half a century later that lithology is the fundamental control of landscape morphlogy in equilbrium terrains. The question remains fundamental today, especially in the highly neglected post-orogenic terrains. Post-orogenic settings represent far-and-away the major part of the Earth's surface but they have received relatively little attention in the last decade's resurgence of interest in the relationships between tectonics and landscape evolution. Numerical modelling has figured strongly in this resurgence, relying on the attainment of steady state landscapes before exploring landscape responses to variations in key input parameters. Despite this dominance of the literature by actively uplifting ('orogenic') settings, recent literature has begun to consider again rates and pathways of landscape evolution in tectonically stable ('post-orogenic'), intra-plate settings. Numerical modelling suggests that a range of interactions may explain the greater-than-expected antiquity of landscapes in such post-orogenic settings. A model combining isostasy, a transition to transport-limited conditions during landscape evolution, and a critical shear stress for erosion could account for the presence of residual topography for hundreds of million years. Field data from the stable intra-plate setting of the SE Australian highlands suggest, however, that other factors may be acting to slow bedrock incision and landscape evolution in the post-orogenic phase. In particular, resistant lithologies may retard or even preclude the headward transmission of denudationally isostatically driven base-level fall. Rejuvenation, be it episodic or continuous, is 'caught up' on these resistant lithologies, meaning in effect that the bedrock channels

and hillslopes upstream of these stalled knickpoints have become detached from the base-level changes downstream of the knickpoints. Until such time as these knickpoints are breached, therefore, catchment relief must increase over time, a landscape evolution scenario that has been suggested at various times throughout the 20^{th} century. These delays may persist for considerable periods, reinforced by very low stream power that reflects low discharges in these often semi-arid settings and their low gradients, as well as low fluxes of sediment to act as erosional ‘tools’. In other words, non-steady state landscapes may lie at the heart of widespread, slowly evolving post-orogenic settings, meaning that non-steady landscapes are the ‘rule’ rather than the exception on the Earth’s surface.