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The emergent natural variability of tectonic forcing on erosional denudation

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Many studies have investigated cause and effect relationships between erosional denudation and tectonic activity in active mountain belts. Comparisons of cosmogenic and thermochronometric data with climatic information are applied to evaluate potential controls (Burbank, Blythe et al. 2003). However, these studies have produced conflicting and contradictory findings (Molnar 2003). We present a new approach to the problem, showing that natural variability in the tectonic forcing, a factor neglected in previous studies, plays a significant role in the evolution of these denudational records. Using a Discrete Element Model (Cundall and Strack 1979; Naylor, Sinclair et al. submitted), with appropriate collisional boundary conditions, we investigate an emergent cyclic behaviour that produces a quasi-periodic tectonic forcing on landscape evolution. This forcing reflects the tendency of thrust wedges to fluctuate between periods of frontal accretion of thrusts, and internal thickening in order to maintain an equilibrium form. In orogenic and accretionary wedge systems, the period of this signal is given by the time taken to propagate and incorporate successive thrust sheets and is given by the wavelength of the thrust sheets divided by the regional convergence rate. The magnitude of the particle uplift signal during internal thickening in the modelled orogen ranges between 0.1 to 0.3 times the thickness of the accreted material. For many settings this would be recorded in steep age/elevation profiles in thermochronometric data. Hence, this work has implication for our understanding and design of field studies comparing erosional denudation with tectonics.

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