Geophysical Research Abstracts
Vol. 14, EGU2012-1087, 2012
EGU General Assembly 2012

Temporal and Spatial Evolution of Dynamic Support From River Profiles: A Framework for Madagascar and Africa

J.D. Paul, G.G. Roberts, and N. White

Department of Earth Sciences - Bullard Laboratories, University of Cambridge, Madingley Rise, Cambridge, CB3 0EZ, UK (e-mail: jdp43@cam.ac.uk)

It is generally accepted that the surface topography of Africa is a manifestation of convective circulation in the sub-lithospheric mantle. Here, we present an inverse method whereby longitudinal river profiles are interrogated to extract quantitative estimates of spatial and temporal variations in the rate of tectonic uplift. Surface processes can provide an important window into transient convective circulation in the sub-lithospheric mantle. River profiles act as 'tectonic tape recorders': we assume the generation of broad, convex-upward knickzones to represent the effect of tectonic uplift shifting the river system into a state of disequilibrium. Profiles evolve through time primarily via the headward retreat of these knickzones. We use a conjugate gradient inverse algorithm to minimise the misfit between observed river profiles – derived from a regional Digital Elevation Model (DEM) – and calculated profiles obtained by varying the uplift rate history. We jointly invert a total of 98 Malagasy and 570 African river profiles to obtain a history of the cumulative tectonic uplift through geological time. We show that Africa has undergone two phases of rapid uplift: first in Eocene times; secondly, since 10 Ma. While the first gave rise to broad, long wavelength topography, the second led to more localised domal swells of high relief. We propose the existence of two wavelengths of dynamic support, reflecting a change in the style of convection in the upper mantle since 50 Ma. Our results correlate strongly with independent geological estimates of uplift across Africa and Madagascar, while our calculated landscape surface following 50 Myr of uplift corresponds closely to a surface fit across present-day drainage divides. Finally we calculate the solid sediment flux delivered to major African deltas as a function of time. This onshore record provides an important indirect constraint on the history of vertical motions at the surface, and agrees well with the offshore flux record, obtained from mapping the thickness of chronostratigraphic sediment packages at the deltas.