Geophysical Research Abstracts, Vol. 9, 02654, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02654

The role of knickzones in governing downstream channel evolution

D. Hobley, H. Sinclair and P. Cowie

Institute of Earth Science, School of GeoSciences, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JW, UK (dan.hobley@ed.ac.uk)

Fluvial erosion sets the style and pace of landscape evolution, both directly and by transmitting base level change signals widely through their networks, modulating the rates and styles of other processes, e.g., landsliding, sedimentation. Examining the response of rivers to non-equilibrium conditions provides a key tool to establish factors controlling fluvial dynamics. This study examines the role of kilometre-scale localised downstream increases in channel slope, here defined as knickzones, in controlling the fundamental form of downstream river long profiles. We use digital elevation model analysis to investigate long profiles and slope-drainage area scaling for three separate field areas – tributaries draining the Ladakh batholith, NW Indian Himalaya, the Fagaras Mountains, Romanian Carpathian Alps, and plateaux surrounding the Red River area, Yunnan province, China. In both the Himalayan and Alpine examples, tributary long profiles show knickzones introduced by development of glaciers in their upper reaches. In the Red River region, two sets of knickzones have been introduced either by change in rate of slip on the Red River Fault or by changes in baselevel on the Red River.

It is well known that the slope-area scaling exponent, or concavity, θ, of "steady state" river channels without knickzones is typically around 0.5. We demonstrate that reaches downstream of knickzones systematically show $\theta > 0.5$ on a scale of many kilometres. The magnitude of θ in these domains correlates with drainage area upstream of the knickzone as a proportion of total drainage area at the end of the measured reaches. This signal is present in all three datasets and is proposed to be generic to all systems where significant slope discontinuities are present on the long profile. In particular, we note that this signal is not unique to tectonically perturbed examples. This observation has significant implications for considering the distribution of erosion and deposition in space and time in fluvial systems displaced away from a “steady state” profile form. For instance, in glacial environments knickzones produced by the bevelling of tributary headwaters by ice will continue to control sediment flux through downstream reaches well after the glaciers themselves have retreated. Detailed geomorphic field surveys in Ladakh have demonstrated the importance of sediment distribution, calibre and flux in producing these trends, and allow us to discriminate between competing mechanisms for generating this signal.