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tectonic/erosion coupling and equilibrium topographies in compressional orogens: insights from analytic and numerical approaches.

J. Lavé (1), V. Godard (2), and R. Cattin (2)

(1) LGCA, Grenoble, France , (2) Laboratoire de Geologie, Ecole Normale Superieure, Paris, France.

Negative feedbacks in tectonic/erosion coupling are commonly believed to push active land forms and systems toward equilibrium topography. However, this classical and intuitive view can be seriously challenged in compressional orogens. Here we present results from analytic and numerical approaches showing, first, that the erosional negative feedback is insufficient in numerous cases to counteract vertical and horizontal tectonic advection and, second, that strong disequilibrium can occur between the major rivers and the average topography in such setting. In active mountainous landscapes, dominated by detachment limited fluvial incision and hillslope landsliding, the scaling relations that characterize both river profiles and planimetric organization of the river network can be linked together to provide analytic solutions (functions of precipitation, bedrock erodability and uplift rate) to describe both the major transverse rivers profile and the mean landscape elevation profile. In these analytic solutions, the behaviour of the major transverse rivers can be approximated by a wave-like equation whereas the interfluve mean topography is controlled by its base level, i.e. the elevation of the transverse rivers, and characterized by a relaxation equation. Consequently, tectonic and topographic steady state can be reached in convergent orogens only when the erosional regressive wave speed of the major rivers (controlled by the erodability, the precipitation, the upper drainage area and the functional form of the fluvial incision law) is higher than the vertical and horizontal tectonic advection rate. However, even in this favourable case, when we introduce the coupling between tectonic and erosion, mechanical criteria and gravitational forces impose maximum values for the crustal thickness and surface elevation, and eventually may inhibit attainment of an equilibrium topography. As shown from results of a numerical model including me-

chanics and erosion, this process may lead to strong disequilibrium between the major transverse rivers and the topography.