Geophysical Research Abstracts, Vol. 7, 10459, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10459

Tectonic and climatic control of non-uniform rock uplift in the Olympic Mountains of Washington State

D. Stolar, G. Roe and S. Willett

Dept. of Earth and Space Sciences, University of Washington, Seattle, WA, USA, dstolar@u.washington.edu

In the Olympic Mountains of Washington State, tectonic, erosional and climatic processes interact to produce non-uniform patterns of exhumation and erosion rate. Long-term erosion rates (>100 kyr) vary systematically across the range from near zero at the west coast to a maximum of nearly 1 mm/yr at the crest of the range. These rates appear to have remained steady for the past 14 Ma. We demonstrate here that this pattern is consistent with results from a model of a critical wedge that is coupled to a simple two-dimensional landscape in which erosion occurs by stream power incision and bedrock landsliding. A simple channel network topology, consisting of a trunk stream and first-order tributaries, implies a positive relationship between rock uplift and relief. Under uniform precipitation, we find that bounds on the relief provided by the critical wedge taper angle lead to rock uplift and erosion rate profiles that must increase from the outlet towards the divide, supporting the view that a non-uniform pattern of erosion is a natural consequence of an eroding critical wedge. Additionally, we find that the rock uplift rate and relief have predictable dependencies on the spatial distribution of precipitation. According to our model, an increase in precipitation produces only a weak relief decrease but a strong rock uplift increase. Available mesoscale weather forecasts from the Olympic Mountains show an orographically-driven increase in precipitation with the maximum rates occurring at the topographic crest of the range. Thus, the erosion rate pattern in the Olympic Mountains might represent the super-position of patterns resulting from the tectonic-erosional system and from orographic precipitation, with both favoring greater rates of erosion and rock uplift near the core of the range.