Geophysical Research Abstracts, Vol. 9, 06362, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06362

Possible environmental effects on modern lithospheric deformation in the Central Alps of Europe

F. Schlunegger, M. Schwab

Exogene Geology Group, Institute of Geological Sciences, University of Bern, Baltzerstrasse 1-3, 3012 Bern, Switzerland, schlunegger@geo.unibe.ch

It has been proposed that the topography of mountain belts has resulted from the dynamic interaction of processes controlling deformation of the lithosphere and processes operating at its surface. In this regard, the Central Alps of Switzerland have been a particularly promising mountain belt for improving our knowledge in this field. Specifically, there is sufficient evidence that the evolution of the Alps experienced distinct geodynamic phases (constructive growth at ca. 18 Ma, and phase of orogen shrinking at ca. 5 Ma) that have been related to variations in climate-driven erosion rates (Schlunegger & Simpson, 2002; Willett et al., 2006). We propose similar feedback mechanisms between crustal deformation and surface erosion to occur at modern times despite multiple phases of glaciations during the Quaternary. We relate the effect of these feedback mechanisms to the particular drainage geometry in the Central Alps. Specifically, the Alpine sediment transfer system comprises two large orogen-parallel drainage basins in the core of the Alps (Rhone and Rhine valleys), and smaller orogen-normal oriented systems (Aare, Kander, Lindth, Ticino). Discharge in the large rivers is approximately 5-10 higher than in the small ones. The large valleys currently experience the highest rock uplift rates of the Central Alps. Specifically, high-resolution levelling techniques (Kahle et al., 1997) yielded a substantial increase in rock uplift rates from the reference benchmark in the foreland to the Alpine core. The contour lines for rock uplift parallel the Alpine strike with two exceptions. These are the Rhone and Rhine valleys where the highest rates of 1.4-1.6 mm/yr are currently measured. Interestingly, the pattern of suspended loads of rivers reveals the same spatial trend. Specifically, modern sediment yields increase from the foreland to the core of the Alps and positively correlate with the pattern of rock uplift rates. Note, however, that there are no evident relationships between sediment yields and the nature of the underlying bedrock, the hillslope morphometries, and the number of hydropower dams. In addition, channel steepness indices of trunk streams are lower in the Rhone and Rhine valleys than in the orogen-parallel systems independent of the extent of glacial overprint. We hypothesize that the spatial coincidence between the location of enhanced erosion, maximum crustal uplift rates and lowest steepness indices suggests a positive feedback between erosional unloading and tectonic forcing. It is then the particular situation of large strike-parallel drainages in the core of the Central Alps that potentially results in release of higher-than-average lithospheric stress in these valleys. It appears then that the available information is sufficient to speculate about possible feedback mechanisms between environmental conditions and lithospheric processes for the temporal scale of decades of years. However, this hypothesis needs a robust test with geodynamic models of coupled lithospheric deformation and surface processes, and with data that improves the spatial resolution of the crustal velocity field and the sediment yields. Further specific value lies in the exploration of simple systems in the Alps, down to the length scale associated with individual faults in the upper crust.

References:

Kahle, H.G., Geiger, A., Bürki, B., Gubler, E., Marti, U., Wirth, B., Rothacher, M., Gurtner, W., Beutler, G., Bauersima, I., Pfiffner, O.A. (1997) Recent crustal movements, geoid and density distribution: contribution from integrated satellite and terrestrial measurements. In: Pfiffner, O.A., Lehner, P., Heitzmann, P., Müller, St., Steck, A. (eds), Results of the National Research Program 20 (NRP 20). Birkhäuser, Basel, pp. 251-259.

Schlunegger, F., Simpson, G. (2002) Possible erosional control on lateral growth of the European Central Alps. Geology, 30, 907-912.

Willett, S.,D., Schlunegger, F., Picotti, V. (2006) Messinian climate change and erosional destruction of the central European Alps. Geology, 34, 613-616.