Geophysical Research Abstracts
Vol. 13, EGU2011-10031, 2011
EGU General Assembly 2011

Alpine pre-glacial topography and Quaternary landscape evolution from (U-Th-Sm)/He, 4He/3He thermochronometry and numerical modelling, Western European Alps

Pierre Valla (1), Peter van der Beek (1), David Shuster (2,3), Jean Braun (1), and Frédéric Herman (4)

(1) ISTerre-OSUG, University of Grenoble, CNRS, Grenoble, France (pierre.valla@ujf-grenoble.fr), (2) Berkeley Geochronology Center, Berkeley, CA, USA, (3) Department of Earth and Planetary Science, UC Berkeley, Berkeley, CA, USA, (4) Geologisches Institut, ETH Zürich, Zürich, Switzerland

The Pliocene-Quaternary evolution of the European Alps reveals a significant increase in both in-situ denudation rates and sediment fluxes to surrounding basins that have been related to a climatically induced erosion pulse and/or relief amplification due to Quaternary glaciations. However, evaluating the net effect of either Pliocene climate change or Quaternary glaciations on mountain belt topography requires direct quantification of relief evolution and suitable tools that provide observational constraints on relief evolution over ∼1 km and ∼1 Ma scales.

Here, we use apatite (U-Th-Sm)/He and 4He/3He thermochronometry data collected along two elevation transects in the Swiss Valais area (Aiguilles Rouges and Aar External Crystalline Massifs) to provide quantitative constraints on the pre-Quaternary topography of the upper Rhône basin. The Rhône valley is a major glacial valley with ∼1.5-3 km present-day relief. 4He/3He data from a subset of key samples are first interpreted in terms of possible thermal histories, which are then compared to denudation and relief scenarios using the 3D thermo-kinematic model Pecube. Thermal modelling results strongly suggest a late-stage exhumation episode in this area that is associated with ∼1-1.5 km of valley deepening over the last ∼1 Ma.

We use these 4He/3He-deduced local constraints to reconstruct the “pre-glacial” longitudinal profile of the Rhône valley, and show that the net effect of Quaternary glaciations has been to both deepen and steepen the Rhône valley, leading to strong local relief increase (i.e. at the valley scale, ∼5-10 km). Using numerical modelling, we extrapolate the pre-glacial Rhône profile to the entire basin and provide a synthetic topography of the area to derive topographic metrics characteristic of the “pre-glacial” landscape. Comparing the pre-glacial to present-day topographies reveals that Quaternary glaciations, while producing a net decrease in the mean topographic elevation, have not significantly modified mean relief at the regional (drainage-basin) scale.

Geodetic measurements reveal present-day regional uplift rates up to 1 mm yr-1 in the Valais. We show that the isostatic response to Quaternary erosional unloading only partly explains present-day rock-uplift rates within the Swiss Alps and should be added to isostatic effects of glacier retreat or regional geodynamic processes to reach measured uplift rates. This presentation was supported by the EUROCORES programme TOPO-EUROPE of the European Science Foundation.