Present-day uplift of the European Alps: mechanisms and relative contributions

Pietro Sternai[1], Christian Sue*[2], Laurent Husson[3], Enrico Serpelloni[4], Claudio Faccenna[5], Thorsten Becker[6], and Andrea Walpersdorf[3]

[1]Geneva University – Département de Sciences de la Terre, Geneva, Switzerland
[2]UMR 6249 - Laboratoire Chrono-environnement – Université de Franche-Comté – Besançon, France
[3]Institut des Sciences de la Terre – Université Joseph Fourier - Grenoble 1, Institut français des sciences et technologies des transports, de l'aménagement et des réseaux, Institut national des sciences de lÚnivers, Institut de recherche pour le développement [IRD] : UR219, PRES Université de Grenoble, Université Savoie Mont Blanc, Centre National de la Recherche Scientifique : UMR5275, Université Grenoble Alpes, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers, Institut national des sciences de lÚnivers – BP 53 - 38041 Grenoble cedex 9, France
[4]INGV – Bologna, Italy
[5]Laboratory of Experimental Tectonics (LET), Universita Roma Tre – Largo San Murialdo 1, 00146 Rome, Italy
[6]Institute for Geophysics, Jackson School of Geosciences – Austin, Texas, United States

Abstract

Recent measurements of surface vertical displacements of the European Alps show widespread uplift at rates of up to _˜2.5 mm/a in the north-western and central Alps and _˜1 mm/a across a continuous region from the eastern to the south-western Alps. Such a rock uplift rate pattern is at odds with the horizontal strain rate field, characterized by shortening and crustal thickening in the eastern Alps and very limited deformation in the central and western Alps. Proposed mechanisms of rock uplift rate include isostatic response to the last deglaciation, long-term erosion, detachment of the western Alpine slab, as well as lithospheric and surface deflection due to sub-Alpine asthenospheric convection. Here, we assess prior work and present new estimates of the contributions from such proposed mechanisms. Lithospheric adjustment to deglaciation and erosion may account for the great majority of the observed surface uplift rates in the eastern Alps, which, if correct, suggests that topography due to plate tectonic related horizontal shortening and crustal thickening is reduced by other mechanisms. In the central and western Alps, the lithospheric adjustment to deglaciation and erosion likely accounts for roughly half of the rock uplift rates, which points to a noticeable contribution by mantle-related processes such as detachment of the European slab and/or asthenospheric upwelling. While it is difficult to independently constrain the patterns and magnitude of mantle contributions to ongoing Alpine vertical displacements at present, future AlpArray-related data should provide additional insights to better constrain these processes. Regardless, it is increasingly clear that interactions between tectonics *s.l.* and surface unloading processes, rather than individual forcings, are required to explain the current Alpine topographic change.

*Speaker