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Geomorphometric dating of uplift: The case of the NW European foreland of the Alpine arc

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Though topography probably contains as much information as the sediment record about the uplift history of elevated regions, separating the time factor from other relief-forming factors and quantifying it remains difficult and uncertain tasks. While inverse modelling of river long profiles (Pritchard et al., 2009) has been increasingly used recently to produce uplift histories of large basins, a concurrent approach relies on catchment-scale morphometry for a range of catchment sizes in order to date the most recent uplift event that imposed rejuvenation of fluvial landscapes. A composite metric R describing the degree of landscape incision based on three nested hypsometric integrals (of whole catchment, drainage network, and trunk stream) has been shown to be predominantly controlled by catchment size A and uplift age (Demoulin, 2011), leading to take the slope of the linear relation between R and log A as a derived index SR directly related to the uplift age (Demoulin, 2012).

This approach appeared especially adapted to explore the causes of Plio-Quaternary uplift in NW Europe, through mapping the recently uplifted areas and evaluating relative uplift ages. Indeed, it is still debated whether uplifted regions across NW Europe attest to lithospheric buckling in front of the Alpine arc or were randomly produced by a swarm of baby plumes. We calculated R for more than 7000 basins >15 km2 and mapped SR spatial variations by moving a 60-km-wide window along five N- to NW-trending zones of alternating Paleozoic massifs (Massif central-Brittany; Rhenish shield; Bohemian massif) and Meso-Cenozoic basins (Paris basin; Franconian basin) covering the whole NW European platform in front of the Alpine arc. The resulting 350 to 750 km-long SR profiles seem to provide the most meaningful time information, better than that obtained with noisier higher-resolution SR maps. Their preliminary analysis especially evidences a systematic increase in SR from south to north across the contiguous Paris basin and Rhenish shield zones, suggesting northward propagation of an uplift wave that started from ~200 km north of the alpine collision front in Pliocene times and travelled across this part of the European platform at a rate in the order of 80 km/My. The Bohemian Massif and Massif central-Brittany zones show more complex SR patterns possibly linked to marginal alteration of uplift propagation by interferences with, e.g., compression in front of the Pyrenees and the Western Carpathians. Surprisingly, in contrast with the Paris basin, the Franconian basin displays fairly uniform low to moderate SR values suggesting that no tectonic perturbation occurred there since the late Early Pleistocene. Overall, the SR map points to an uplift signal coherent at the continental scale but not directly compatible with lithospheric folding. In conclusion, the R/SR geomorphometric approach of uplift chronology provides a wealth of data, whose in-depth analysis will help get fresh insight into the timing and causes of Plio-Quaternary uplift in NW Europe.

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Geological control of the Outer Western Carpathians' relief dvelopment: from basinal stage to gravitational collapse – a new approach

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The relief formation of the Outer Carpathians was usually considered to be connected with geological factors, such as tectonic structures, differences in rock strength, and neotectonic movements (e.g. Starkel, 1972). Recent study indicates, that the Carpathian morphology development is strictly related to the stages of geological formation of this orogen (including several recently discovered stages) (Jankowski & Probulski, 2011; Jankowski & Margielewski, 2014). The foundation of morphology dates back to the stage of basinal deposition (e.g. formation of chaotic complexes that subsequently influenced the relief shaping, gravitational positioning of rock massifs). The next stages responsible for morphology are compressional stage of the Carpathian orogen formation, the stage of secondary tectonic deformations, such as strike-slip faulting, radial extension and large extensional collapse of the rock massifs (Jankowski & Margielewski, 2014; Jankowski, 2015). The recent study confirms, that the altitudinal difference between the Beskidy Mountains (Beskidy relief zone) and the belt of the Carpathian Foothills (Foothills relief zone) considered to be connected with the differences of rocks strength till now, is related to the structural position of various segments of orogen that was formed during the compressional stage of its evolution. The tectonic elements (units) formed during the earliest stage of compression (Magura, Dukla and Silesian Units) building the elevated Beskidy relief zone, take the highest altitudinal position (800-1300 m asl), whereas the tectonic elements (units) which were subsequently included to the migrating Carpathian orogen (N part of Silesian Unit as well as Skole and Stebnik Units) take the lower topographic position, i.e. Foothills relief zone (Jankowski & Margielewski, 2014).

The stages of strike-slip faulting and gravitational collapse are responsible for the formation of intermountain depressions of pull-apart type, such as the Orawa-Nowy Targ Basin and the Nowy Sącz Basin, as well as huge regional flower structures with tectonic