



## **Large scale, small amplitude, post-Miocene surface uplift in the non-glaciated Eastern Alps: river profiles analysis and cosmogenic-derived $^{10}\text{Be}$ denudation rates**

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In the ongoing debate about the increase in denudation rates around 5 Ma in the Alps and its possible causes and consequences on the topographic evolution of the orogen, the Eastern Alps is a far less studied area than the Swiss Alps. In this contribution, we present in-situ cosmogenic  $^{10}\text{Be}$  derived denudation rates from the Eastern end of the Alps, at the transition with the Pannonian Basin. This unglaciated region is in a different climatic and tectonic setting than the Swiss Alps and is still undergoing a moderate N-S convergence, providing the chance to isolate the influence of tectonically related uplift on erosion and landscape morphology.

River profile analysis highlights a disequilibrium landscape across two unglaciated areas of the Eastern Austrian Alps (Koralpe and Fischbacher Alpen), that cannot be related to lithology or climate. A continuous 'relict landscape' exists in the upper portions of the two areas, which, is incised by several hundred meter deep gorges. Some rivers in these two areas have a sharp knickpoint separating the river profiles into their relict and actively incising parts. We use the calculated concavity and steepness indexes to project the relict river profile (upstream of the knickpoint) above the equilibrated lower section of the river. The total and active incision into the relict landscape is 100-200 m for Fischbacher Alpen and 250-350 m for Koralpe. This incision can be used as a proxy for the total amount of surface uplift of the relict landscapes relative to the surroundings.

$^{10}\text{Be}$  derived denudation rates of 17 catchments across the region show clear differences between the relict and incising portions of the landscape. For Fischbacher Alpen, the denudation rates of the relict and incised landscapes are 94 m/Ma and 125 m/Ma respectively. Similarly, across Koralpe, the average denudation rate of the relict landscape is  $55 \pm 9$  m/Ma, while catchments within the incised portion are 65-213 m/Ma and average 122 m/Ma. We observe a good positive linear correlation between the denudation rates and the normalized channel steepness index of the main channel at the confluence between the measured catchment and the main channel. These results suggest that the denudation rates of these small catchments ( $<2\text{km}^2$ ) are primarily controlled by disparate rates of river incision across the region.

Together, these data show a clear signal of tectonic uplift on both the landscape morphology and denudation rates. Based on previous studies, we infer that the incision and the surface uplift of the relict landscapes started at the end of Miocene (around 6-5 Ma) in response to the inversion of the Styrian basin. However, the driver of this post-Miocene large scale small amplitude uplift ( $<500\text{m}$ ) that affected the easternmost Alps, the Styrian Basin and the northern Molasse Basin remains unclear.