



Deciphering the driving forces of short-term erosion in glacially impacted landscapes, an example from the Western Alps

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Tectonic uplift is the main driver of long-term erosion, but climate changes can markedly affect the link between tectonics and erosion, causing transient variations in short-term erosion rate. Here we study the driving forces of short-term erosion rates in the French Western Alps as estimated from in-situ produced cosmogenic ^{10}Be and detrital apatite fission-track thermochronology analysis of stream sediments. Short-term erosion rates from ^{10}Be analyses vary between ~ 0.27 and ~ 1.33 mm/yr, similar to rates measured in adjacent areas of the Alps. Part of the data scales positively with elevation, while the full dataset shows a significant positive correlation with steepness index of streams and normalized geophysical relief. Mean long-term exhumation and short-term erosion rates are comparable in areas that are exhuming rapidly (>0.4 km/Myr), but short-term rates are on average two-three (and up to six) times higher than long-term rates in areas where the latter are slow (<0.4 km/Myr). These findings are supported by detrital apatite fission-track age distributions that appear to require similar variations in erosion rates. Major glaciations strongly impacted the external part of the Alps, increasing both long-term exhumation rates as well as relief (e.g. Glotzbach et al. 2011; Häuselmann et al. 2007; Valla et al.). Based on our data, it seems that glacial impact in the more slowly eroding internal part is mainly restricted to relief, which is reflected in high transient short-term erosion rates. The data further reveal that normalized steepness index and ridgeline geophysical relief are well correlated with (and could be used as proxies for) short-term erosion, in contrast to slope, corroborating studies in purely fluvial landscapes. Our study demonstrates that climate change, e.g. through occurrence of major glaciations, can markedly perturb landscapes short-term erosion patterns in regions of tectonically controlled long-term exhumation.

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