Post-glacial geomorphic response, erosion dynamics and sediment transfer in the Ariège catchment (Eastern Pyrenees, France)

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Abstract

Mountainous landscapes have been strongly shaped by Quaternary glacial-interglacial cycles, yet the impact of these oscillations on topographic relief, erosion and sediment transfer remains difficult to quantify. Here, we investigate the geomorphic response of the Ariège catchment (Eastern Pyrenees, France), a high-relief area extensively glaciated during the Quaternary and the Last Glacial Maximum, using detrital terrestrial cosmogenic nuclides (TCN).
We analyzed 10Be and 26Al concentrations in modern river sediments collected along the main Ariège River and its tributaries, and compared them with Lateglacial and fluvio-glacial deposits. This approach allows us to assess differences between glacial and post-glacial sediment TCN signatures, evaluate sediment transfer dynamics, and derive catchment-averaged denudation rates.

Modern river sediments show 26Al/10Be ratios of 6-6.75, consistent with surface production and simple sediment transfer dynamics. Output denudation rates display strong spatial variability, ranging from 33 to 294 mm/ka in the Ariège and tributaries. This spatial variability is primarily controlled by topographic metrics, with a significant correlation between denudation rates and averaged catchment slope or channel steepness index.
In contrast, 10Be concentrations in modern sediments are 2-5 times higher than in Lateglacial and fluvio-glacial deposits, revealing a shift between glacial and interglacial conditions. These results suggest that glacial erosion efficiently affect TCN concentrations, following ice shielding but not necessarily increased erosion rates, whereas post-glacial conditions are characterized by progressive re-equilibration toward an interglacial TCN signal. Our work contributes to a better understanding of the sensitivity of alpine landscapes to topo-climatic forcing and associated changes in geomorphic processes over glacial-interglacial oscillations.

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