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# Controls on erosion and weathering in the Alps and East Africa: The significance of 10Be-derived denudation rates and other proxies

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The analysis of terrestrial cosmogenic nuclides (TCN), and especially of in-situ produced 10Be, has become a widely used tool to quantify catchment-wide denudation rates and to interpret the processes driving erosion in a variety of settings. However, 10Be-derived denudation rates are insensitive to erosion of lithologies with low quartz contents and may be biased in settings with significant contributions of glacial erosion or mass-wasting processes. Accordingly, the interpretation of such denudation rates needs to be exercised with great caution and preferably be combined with results from other proxies such as provenance analysis, sediment budgeting and modern river loads.

To illustrate the importance of multi-proxy approaches to tackle those problems, we here present two case studies, one from the European Alps, a mountainous and glaciated landscape in temperate climate, and the second from the East African rift system, a tectonically young and active landscape in a tropical climate.

In the Alpine upper Rhône basin, located in the Central Swiss Alps, 10Be-based catchment-wide denudation rates were compared with results from a comprehensive sediment tracing approach and modern gauging-derived sediment loads. Longer-term 10Be-based denudation rates suggest (1) up to eight times higher sediment loads compared to modern measurements and (2) higher contributions of metamorphic rocks located in the South of the basin compared to the source contributions modelled through sediment fingerprinting. We interpret this divergence through a recent shift of erosion towards areas affected by rapidly increasing temperatures and glacial retreat. High inputs of glaciogenic material explain both the abnormally high 10Be concentrations and the dominance of granitic material, because most glaciers are located on granitoid bedrock.

In East Africa, warm and humid conditions result in high chemical weathering rates, especially from catchments comprising easily soluble Quaternary volcanic tephras. Because these are quartz-depleted, the 10Be-based denudation rates are insensitive to their weathering signal and thus systematically underestimate the modern sediment loads. While the 10Be signal shows an increase of denudation rates with increasing elevation, this topographical trend is not reflected in the chemical river loads, which seem to be controlled by temperature instead.

In summary, our studies illustrate the different sensitivities of different methods and show that only their combination allows for a comprehensive deciphering of the processes and factors controlling erosion.