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Contrasting denudation rates of bedrock erosion and river sediment – a cosmogenic nuclide approach in northern Chile

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Terrestrial cosmogenic nuclide concentrations measured on bedrock, alluvial sequences and in river sediments can be used to estimate landscape denudation rates over different spatial and temporal scales. By investigating multiple terrestrial cosmogenic nuclides (radionuclide and stable) the steadiness of processes such as weathering, sediment generation and transport as well as depositional processes can be evaluated. Hence, such data provide valuable information on the interaction of climate and tectonics and landscape evolution. We have produced such a dataset in the Central Andes of northern Chile. ^{10}Be, ^{21}Ne, and ^{26}Al derived bedrock denudation rates increase markedly along a transect crossing the hyperarid Coastal Cordillera and Western Escarpment to the semiarid Western Cordillera and thus follow the present rainfall gradient. TCN integration times and independent data suggest this trend has prevailed at least since the Pleistocene and perhaps since the Pliocene. In contrast, catchment wide denudation rates from the Rio Lluta - following the same climate gradient - indicate steady processes between hillslopes and channels only in the Western Cordillera. In the lower river course the comparison of ^{10}Be and ^{21}Ne concentrations clearly indicates multiple sources of sediment input, reworking and sediment storage.

The multiple terrestrial cosmogenic nuclides method can unravel the effect of complex fluvial dynamics on sediment transport and storage, largely overseen with only a single nuclide. Yet, unambiguous quantitative conclusions may still be difficult with the multiple nuclide approach. In northern Chile the multiple nuclides in river sand samples do not take up primarily the climate modulated landscape signals but also signals caused by internal fluvial dynamics.

In addition to quantitative aspects of landscape analysis, tests on the suitability of other minerals and isotope combinations (sanidine, magnetite with ^{21}Ne, ^{36}Cl and ^{3}He, respectively and ^{14}C in quartz) for cosmogenic exposure age dating and erosion rate studies may provide fundamental information on climate dependent nuclide systematic as well as complex outcrop scenarios.