**(Talk)**

## Three decades tracing erosion and sediment with cosmogenic nuclides - where do we go next?

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Cosmogenic nuclides, primarily $^{10}$Be, have revolutionized our understanding of erosional systems. Both $^{10}$Be produced within minerals (*in situ*) and that produced in the atmosphere (meteoric) provide useful information about the rate and spatial distribution of erosion. Early work quantified bare rock erosion rates on single outcrops by measuring $^{10}$Be produced *in situ* by cosmic-ray bombardment[1]. A decade later, the *in situ* method expanded to consider the scale of drainage basins through the analysis of fluvial sediment[2]. Soon after, more complex, process-oriented studies began to quantify the mass flux of sediment down hillslopes and the rate of soil formation[3]. Meanwhile, meteoric $^{10}$Be was being employed to understand both hillslope and fluvial processes, including human-induced erosion[4]. Recently, both meteoric and *in situ* $^{10}$Be have been used as sediment tracers in fluvial networks to help pinpoint the source of sediment in transport[5].

After three decades of data collection, one can look back at thousands of measurements made in samples collected from dozens of field areas. Some themes emerge[6]. Bedrock erosion rates, typically measured in samples collected from outcrops along ridgelines, are usually slower than basin-scale erosion rates inferred from $^{10}$Be concentrations in fluvial sediment, which integrates processes active across entire landscapes. Basin-scale erosion rates scale positively with a variety of topographic metrics including average basin slope and relief. Tectonic setting, expressed as the intensity of seismic shaking, correlates positively with erosion. In well-indurated, quartz-rich rocks, lithologic influences are subtle.

Looking beyond erosion rates, we have employed $^{10}$Be in several novel ways. In New Zealand and northeastern North America, we have used the concentration of meteoric $^{10}$Be in fluvial sediment to fingerprint sediment sources in river systems, in one case showing the influence of massive landsliding and in the other showing that sediment sourced from different elevations is isotopically distinct. In Greenland, high concentrations of meteoric $^{10}$Be in silt extracted directly from the ice sheet suggest low rates of glacial erosion and the likelihood of significant interglacial retreat and soil development[7]. In contrast, clasts collected alongside the silt samples contain extremely low concentrations of in situ $^{10}$Be suggesting grain-size dependent sources and perhaps erosion histories[8].

While estimating erosion and sediment generation rates as a function of lithology, tectonic setting, and climate may well continue to be the bread and butter of cosmogenic nuclide analysis, using these isotopes as tracers offers great potential to determine better the sources and fate of sediments over $10^1$ to $10^5$ year time scales.

### References

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