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^{10}Be erosion rates controlled by normal fault activity through incision and landslide occurrence

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Quantifying erosion rates, and how they compare to rock uplift rates, is fundamental for understanding the evolution of relief and the associated sediment fluxes. The competing effects of rock uplift and erosion are clearly captured by river incision and landsliding, but linking these four important landscape processes remains a major challenge. We address these questions using field data from southern Italy, and quantify the geomorphic response to tectonic forcing. We present 15 new ^{10}Be catchment-averaged erosion rates, collected from catchments along five active normal faults with excellent slip rate constraints. We find that erosion rates are strongly controlled by fault slip rates and that this relationship is mediated by the degree of catchment incision and landslide activity. We find that ^{10}Be samples from low-relief, unincised areas above knickpoints yield consistent erosion rates of $\sim$ 0.12 mm/yr, while samples collected below knickpoints have erosion rates of $\sim$ 0.2 - 1.0 mm/yr. This comparison allows us to quantify the impact that transient incisional response has on erosion rates. We demonstrate that in this area incision is associated with frequent, shallow landsliding, and we show that the volumes of landslides stored in the catchments are highly correlated with ^{10}Be-derived sediment flux estimates, suggesting that landslides are likely to be a major contributor to erosional fluxes. Despite widespread landsliding, CRN samples from the studied catchments do provide reliable estimates of catchment-averaged erosion rates, as these are consistent with fault throw patterns and rates. We suggest that this is because landslides are frequent, small and shallow, and are stored on the hillslopes for up to $\sim 10^3$ yrs, representing the integrated record of landsliding over several seismic cycles; and test this hypothesis using a numerical model of landsliding and CRN dynamics. Our results show that adequate CRN mixing can occur through runoff as landslides are stored on the hillslopes, as long as landslide recurrence intervals are short, which is supported by the erosion rate magnitudes and previous landslide studies in the area. This study contributes to our understanding of erosion and sediment supply in tectonically-active areas, and offers novel insights into the use of CRN to infer erosion rates in areas of intense landslide activity.