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Erosional flux from tectonically active landscapes: Case studies from Southern Italy

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Erosion and sediment supply are fundamentally important controls on landscape evolution, governing the denudation of relief, the stratigraphy deposited in basins, and the ultimate destruction of orogens. However, quantifying the rates, timescales, and predominant processes of erosion remains a major challenge in many tectonically active areas.

Here, we use Southern Italy as a case study to demonstrate how these challenges can be overcome. We present 15 new ^{10}Be catchment-averaged erosion rates, for systems distributed along 5 active normal faults for which we have excellent constraints on throw rates along strike and uplift history. These footwall catchments have a total relief of up to 1800 m and throw rates up to 1.4 mm/yr. We show that sediment supply estimates based on the ^{10}Be erosion rates agree well with sediment supply predictions based on the fault throw profiles. Our results suggest that about 80% of the material uplifted by the faults is being eroded at a similar magnitude to the fault throw rates, offering new insights into the topographic balance of uplift and erosion in this area.

These findings imply that active normal faulting is the primary control on sediment supply in Southern Italy. Our field observations suggest that landslides are an important source of sediment in our study area, and are largely driven by incision in response to fault activity. Using a field-calibrated landslide inventory, we estimate landslide-derived sediment flux for our sampled catchments. These estimates correlate well with total sediment flux estimates, demonstrating quantitatively that landslides must be a major source of sediment. Their erosional signal is adequately captured by the ^{10}Be analyses most likely because of the high frequency of small landslides and their high spatial density in these catchments (typically $>$10% of the total area), which ensures sufficient sediment mixing. Finally, we use our results to calibrate the BQART model of sediment supply, enabling us to make sediment flux predictions for a total of 158 similar catchments along 8 studied active normal faults in Southern Italy. This large dataset offers an unprecedented opportunity to study how erosional sediment fluxes relate to fault activity and landsliding.