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Quantifying the controls on grain size export from tectonically perturbed catchments: Case studies from Sicily, Calabria and Abruzzo, Italy

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The magnitude, locus and characteristics of sediment export from catchments to neighbouring basins plays a significant role in controlling depositional stratigraphy. Fundamentally, the boundary conditions for sediment release from catchments are set by tectonics and climate, modulated by lithologic, hydrologic and geomorphic controls operating over the relevant time or length scale. A predictive understanding of sediment export to basins therefore requires (i) the integration of data illustrating the characteristics of sediment delivery within catchments and (ii) detailed constraints on how this supply signal evolves down-system, for a wide range of controlling variables.

Here we address this challenge. Firstly, we present a detailed data study linking hillslope sediment supply to trunk stream grain size evolution for three catchments with drainage areas > 30 km^2 in northern Sicily where tectonic uplift rates are > 1 mm/yr and where lithologies are well-mapped, using both sieved weight fraction and Wolman point count methodologies. We find that sediment input from coarse debris flows, rather than landslides, plays a dominant role in setting channel grain size and that coarse-fraction sediment export from catchments is intimately linked to channel-hillslope geomorphic coupling.

Secondly, we present detailed data on grain size export from the outlets of more than 40 tectonically perturbed catchments across Sicily, Calabria and Abruzzo, where we have excellent constraints on tectonic uplift rates, lithology and catchment hydraulic geometry. We demonstrate that for catchments in topographic steady-state, grain size release is strongly controlled by rock type, but is insensitive to drainage area and local uplift rates that are < 1 mm/yr. In contrast, for catchments responding transiently to tectonics, the calibre of sediment release is strongly controlled by the degree of tectonic perturbation. The southern Italian data-sets allow us to provide first order estimates of the volume and grain size distribution of sediment exported to the straits of Messina as a whole, and we use terrace data to show there has been little change to this sediment release signal in the last 200 kyr.

Together, these results allow us to evaluate the relative importance of upstream source controls in setting the characteristics of sediment release from tectonically perturbed catchments to basins and provide new data to test the outputs of sediment routing system models.