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Response of erosional and depositional landscapes to tectonic perturbation

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Tectonic processes fashion erosional and depositional landscapes by driving patterns of uplift and subsidence upon which geomorphic processes act. One of the simplest ways in which to study the interaction between tectonic forcing and landscape response is to target relatively simple systems that can be easily surveyed and involve a closed mass budget. Such relatively simple systems include transverse 'frontal' catchments in extensional footwalls and adjacent hangingwall sediment fans. We show from a landscape evolution model tuned to the Basin & Range province, and from field observations in the central Apennines of Italy, that perturbations of slip rate on range-bounding faults produces a transient response in the erosional topography of the footwall with a time scale of order 1 Myr. When coupled with sediment efflux to the hangingwall basin, we model stratigraphic patterns dominated by this transient behaviour, including backstepping at the time of the step change in slip rate, followed by gradual (1 Myr) recovery. Transient behaviour following a change in slip rate is compared to autogenic (unforced) evolution of catchment-fan systems controlled by internal dynamics and choice of downstream boundary condition.

A challenge in the field of Earth surface dynamics is the understanding of the probability density function of grain size in the sediment evacuated from upland catchments, and its dispersal downstream through the sediment routing system. We take idealized pdfs of grain size and simulate downstream trends in grain size caused by selective deposition over a template generated by extensional tectonics. Consequently, we are able to add sedimentological texture to the hangingwall basin-fill that can be directly tested through field observations. We conclude that the transient backstepping caused by a slip-rate increase simulated in previous studies is associated with a pronounced fining of grain size, followed by a cycle of coarsening up. This opens up further possibilities of linking tectonic perturbations of different types to stratigraphic patterns in the basin-fill.