# Surface Responses to Subducting Slab Detachment in Small Convergent Mountain Ranges

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Alpine-type mountain ranges emerge from the collision of two continental plates. During the collision the subducting plate descends into the mantle. Given favourable thermo-physical conditions and time, the lower end of the subducting plate detaches from its upper section causing a dynamic surface uplift response over a geologically brief time period. This study investigates how, and if, such a process can be detected solely from the geomorphological record. Furthermore, it aims to identify minimum surface uplift conditions that would favour such observation in nature. The experimental set-up links typical kinematics for the lateral growth of a doubly-vergent orogens over 15 Myr with a surface processes model. This includes isostatic responses to erosion as well as buoyancy effects caused by crustal thickening. Two fundamental slab dynamics scenarios have been tested: the first scenario subjected the evolving orogen to a single surface uplift event representative of a slab break-off (Fig. 1). The orogen responds by immediate increases in mean elevation by ~10%, erosion rates by more than 10%, and river steepness by ~5% assuming a parabolic surface uplift of 1 mm/yr over 1 Myr across-strike the orogen. Notably, the orogen undergoes a prolonged decay period over ~1 Myr to reach conditions prior to the surface uplift event. The second scenario assumes an along-strike propagating surface uplift representing a slab tearing event. Geomorphological responses are similar to the first scenario but restricted to the location of highest surface uplift in space and time causing an asymmetric response along-strike the orogen. Both scenarios induce a two-step inversion of the foreland basins: firstly, as a result of the surface uplift event itself, and secondly, followed by the isostatic response to erosional unloading during the prolonged landscape decay. Hence, the study argues that the identification of geologically short-lived surface uplift events in Alpine-type orogens, caused, for example, by break-off or tearing of the subducting slab, require the observation of a coeval increase in erosion, local relief, river steepness and the inversion of the foreland basins during phases of surface uplift and erosional unloading.

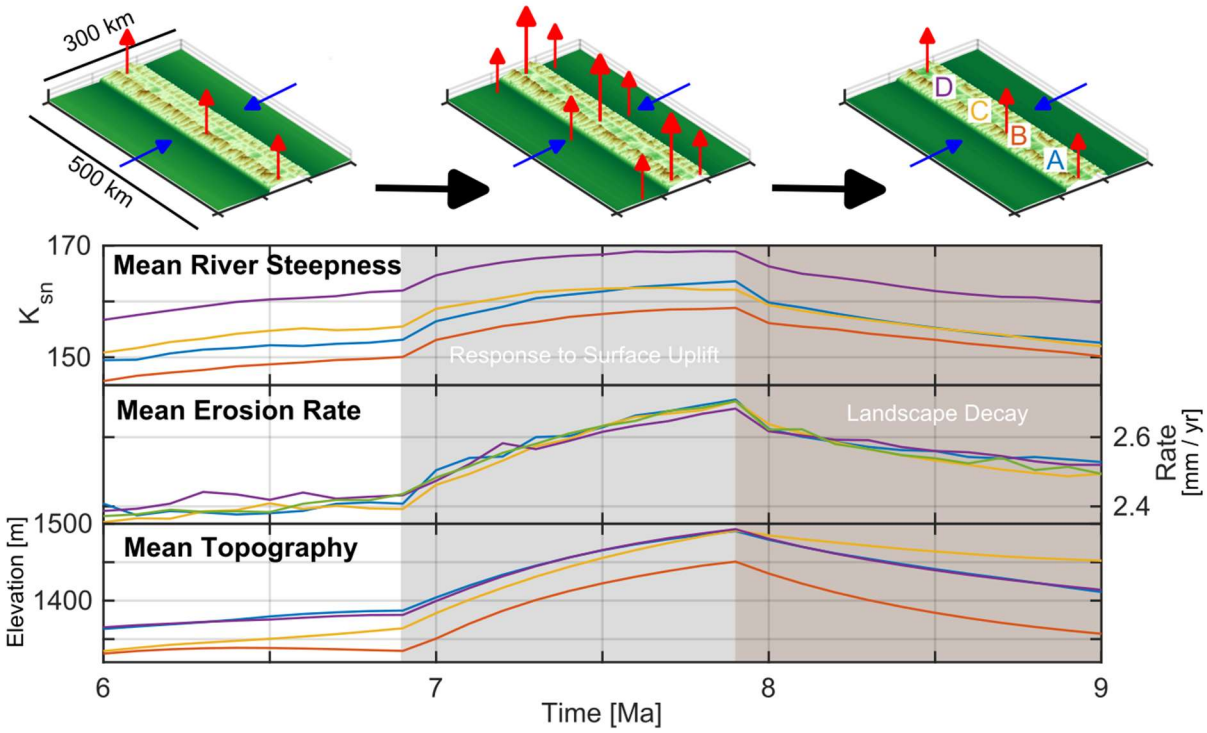


**Figure 1:** Geomorphological responses in an active Alpine-type doubly-vergent orogen to a symmetric, 1 Myr surface uplift event at 6.9-7.9 Ma at a rate of 1 mm/yr. (Top) Surface processes model output pre-, syn- and post-surface uplift. Blue and red arrows represent imposed tectonic convergence and surface uplift. (Bottom) Temporal evolution of river steepness, erosion rate and topography in colour-coded patches A to D. Note the immediate response to the surface uplift event in contrast to the prolonged landscape decay (~1 Myr) back to levels prior to the event.