Reconstructing Forearc Migration Geodynamics by Inverting River Long Profiles: the Case Study of the Calabrian Forearc (Central Mediterranean)

Interactions between deep Earth geodynamics and Earth surface processes are well documented at various scales, but many challenges remain in how inversion of a fluvially incised landscape should be interpreted in terms of long-term geodynamics or how deep Earth dynamics impact natural hazards. Here, we present results from geomorphic stream channel metrics and modeling of long profiles of streams draining the Tyrrhenian (northern) flank of Sicily (Italy), to assess the inferred, rapid, west-to-east horizontal translation of the Calabrian forearc. A detachment-limited stream power model-based determination of landscape response time and knickpoint migration provides an independent prediction for transient base level fall associated with the sweeping forearc over the past ~4 Ma. The model shows that two pulses of time-transgressive, west-to-east propagating base level fall occurred in the drainages of northern Sicily, where parallel north-flowing streams are arranged across the migrating path of the forearc. The long profile analysis indicates that the paired uplift pulses last ~1 Ma and are separated in time by ~1.5 Ma, consistent with the west-to-east passage first of the forearc high, followed by dynamic uplift in its wake due to sub-lithospheric mantle flow, as proposed in other plate boundary settings. The ongoing surficial response to these dynamics is represented by river incision, knickpoint migration, and drainage divide migration. Furthermore, these processes steepened the landscape, leading to an increase in active landsliding and contributing to the natural hazards in this region.

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