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Landscape response to normal fault growth and linkage in the Southern Apennines, Italy.

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It is now well-established that landscape can record spatial and temporal variations in tectonic rates. However, decoding this information to extract detailed histories of fault growth is often a complex problem that requires careful integration of tectonic and geomorphic data sets.

Here, we present new data addressing both normal fault evolution and coupled landscape response for two normal faults in the Southern Apennines: the Vallo di Diano and East Agri faults. By integrating published constraints with new data, we show that these faults have total throws of up to 2100 m, and Holocene throw rates of up to 1 mm/yr at their maximum. We demonstrate that geomorphology is effectively recording tectonics, with relief, channel and catchment slopes varying along fault strike as normal fault activity does. Therefore, valuable information about fault growth and interaction can be extracted from their geomorphic expression.

We use the spatial distribution of knickpoints on the footwall channels to infer two episodes of base level change, which can be associated with distinct fault interaction events. From our detailed fault throw profiles, we reconstruct the amount of throw accumulated after each of these events, and the segments involved in each, and we use slip rate enhancement factors derived from fault interaction theory to estimate the magnitude of the tectonic perturbation in each case. From this approach, we are able to reconstruct pre-linkage throw rates, and we estimate that fault linkage events likely took place 0.7 $\pm$ 0.2 Ma and 1.9 $\pm$ 0.6 Ma in the Vallo di Diano fault, and 1.1 $\pm$ 0.1 and 2.3 $\pm$ 0.9 Ma in the East Agri fault. Our study suggests that both faults started their activity at 3.6 $\pm$ 0.5 Ma. These fault linkage scenarios are consistent with the knickpoint heights, and may relate to soft-linkage interaction with the Southern Apennines normal fault array, the existence of which has been the subject of considerable debate. Our combined geomorphic and tectonic analyses shed light on this important issue. This method for reconstructing normal fault evolution could potentially be applied to any normal faults in which constraints on fault throw and footwall relief can be linked to the transient response of catchments to a tectonic perturbation.