Imperial College London

Natural Environment Research Council

2021_33: Tectonics from topography in Central Greece: decoding the history of fault growth and landscape evolution in the Corinth Rift

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Terrestrial landscapes can record the evolution, growth and slip rate of active faults. However, the speed at which rivers respond to tectonics and the way in which fault growth controls sediment supply from catchments to basins remain controversial. For instance, the erodibility of bedrock may impact the way in which landscapes respond to tectonics and the type of sediment produced as a result. Where landscapes can be used as a proxy for fault evolution, this would provide a powerful new tool to constrain the seismic hazard of faults and would help us link stratigraphic records with the onshore history of faulting.

The Gulf of Corinth is an ideal natural laboratory to explore the use of landscapes to resolve fault interaction and sediment transport pathways. It is one of the fastest extending rifts in the world with extension rates from 5 mm/yr to 15 mm/yr from East to West. The southern margin of the rift has a series of active faults which have perturbed rivers for at least the last 1 Myrs; the northern margin appears to be less active today. Within the basin, seismic reflection data has revealed that before 700 ka the rift was controlled by both south and north dipping faults forming major depocentres in the East and West. At ~700 ka these depocentres linked, coincident with transfer of strain from south to north dipping faults. In some parts of the rift strain has been localised on north dipping faults for periods greater than 1 Myr and in others new north-dipping faults initiated in the last ~700 ka.

These differences observed offshore are likely to be recorded on land; however reconstruction of active fault evolution from geomorphic data has remained equivocal. While some studies have argued for a westward shift in fault activity over time with distinct phases of uplift, others have claimed that a composite master fault grew along-strike from the rift centre ~0.7 ka, which is said to have led to a radical change in rift geometry and tectono-sedimentary dynamics. These hypotheses have not been reconciled with seismic evidence or with detailed fieldwork.

This PhD has three main aims. You will:

(i) Refine the evolutionary history and current slip rates of faults along the Corinth Rift by integrating subsurface geologic data with careful topographic analyses.

(ii) Conduct fieldwork to assess the role of varying bedrock strength in controlling landscape response times to active faulting using in-situ measurements of rock strength and by numerical modelling.

(iii) Characterise sediment routing system response to fault evolution, including the grain size release from fault bounded catchments to the Gulf. Where appropriate these data will be compared with piston and core data that have recently been collected.

The results will provide new constraints on seismic hazard in the Corinth rift, generate new insights into lithological controls on landscape evolution and will show how fault growth controls sediment delivery to basins.