2024_32_ESE_AW: Landscapes, seismic hazard and fault growth: normal faulting in the Gulf of Evia and Apennines compared

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An important part of seismic hazard assessment involves constraining active fault geometry and slip rates. Normal fault segments commonly interact and link as faults grow, and although faults appear isolated at the Earth's surface they may be linked at depth. This means that faults could be much longer, and therefore host a much larger earthquake than would be determined from surface mapping alone. In addition, the segmentation and linkage of faults influences sediment transport into basins, thus controlling sedimentary depocentre characteristics. A lack of seismic reflection imaging and high-density neotectonic indicators along the full length of active faults, also can mean that it is difficult to reconstruct active fault evolution in detail. One way to address this issue is landscape analysis of fault growth and interaction, where the generation of topography, the propagation of knickpoints and the evolution of drainage networks can in principle all give detailed insights into fault growth and evolution over timescales of 10^4 to 10^6 years. However, these topographic insights are not often reconciled with subsurface measures of fault behaviour and evolution, for example from seismic reflection data. Consequently, significant uncertainties exist in how topographic and sub-surface datasets should be integrated to understand fault behaviour and kinematics across a range of timescales.

This PhD will address this important problem. We will use two well-constrained and data rich locations – the Gulf of Evia, Greece and the Apennines of Italy as natural laboratories to explore how fault initiation, kinematics, and associated erosion and sediment generation, are recorded in both landscape and subsurface data. We will first use quantitative geomorphology techniques applied to high resolution topographic data sets. Using quantitative analyses including drainage network and knickpoint propagation analyses, as well as topographic metrics and field observation, we will seek to determine how the history of normal faulting is recorded in the landscape over a range of timescales. Recovered fault evolution scenarios will be compared with those newly interpreted from subsurface data sets, including seismic reflection data. Based on these data sets seismic hazard will be constrained, including the maximum credible earthquake size.

This project would suit a student with interests in active faulting; landscape dynamics; and earthquake hazards and their impact on society. A key aspect of the project will involve integrating a range of data sets across a range of temporal and spatial scales. There will be the opportunity to visit and study active faults in Greece and Italy and to attend conferences internationally and in the UK.