Development, deformation style, and seismic hazard of large normal faults

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Project description: The southern East African Rift propagates through relatively cold, old, continental crust with greater elastic thickness than most extensional settings. A consequence of this elastic thickness is the development of long normal faults (border faults), which may be capable of producing earthquakes as large as magnitude 8.0. Because the repeat times for large earthquakes in the relatively slow moving rift are significantly longer than the historical record, the seismic history and hazard of these border faults is largely unknown.

In this interdisciplinary study, we will combine geophysical data on recent and present deformation along and around border faults, with geological observations of fault geometry and fault rock assemblage, to constrain models of potential seismic hazard in the southern East African Rift.

A new strain rate map for East Africa will allow for exploring the rate at which the border faults are accumulating elastic strain. Based on this, the repeat time for characteristic earthquakes may be estimated and built into a probabilistic seismic hazard assessment. Such an assessment will also require information about fault segmentation and stress transfer between different faults, and possible aseismic strain accommodation. In addition to available geophysical data, these parameters may be constrained based on geological factors. Field investigations of border faults, and the rocks in which they have developed, may elucidate fault geometry and its relation to basement geology, fault deformation history and likely slip style. In particular, the mineralogy and microstructure of the fault rocks themselves can be compared to other faults and experimental data.

Training opportunities: Field studies in the East African Rift Valley

Optical microscopy of fault rocks sampled during field work.

Mapping at all scales is to constrain fault geometry and the relation between fault geometry and pre-existing basement structures, and to investigate the internal structure and composition of border faults (facilities at Cardiff University) – such mapping is excellent practice for work in both natural hazards and in exploration for fault-hosted mineral deposits

Use of geophysical data to constrain large scale geometry of border faults, and particularly to estimate recent and present seismic and aseismic deformation. Ties in with NERC-Large Grant 'Looking into Continents from Space' (2013-2018, PI Parsons, Oxford) which includes the production of a strain rate map for East Africa from satellite data (led by Biggs). In addition to GW4 training opportunities, the student will be eligible for training and meetings arranged by both the LICS grant and BGS-COMET.

The student will integrate geological and geophysical data in a seismic hazard model as used by civil engineers to estimate natural hazards to buildings (in collaboration with K. Goda). This interdisciplinary approach will expose the students to the data and assumptions needed to make hazard models, in addition to learning how to construct such models.