Imperial College London

Natural Environment Research Council

2024_38_ESE_IB: Crust and mantle seismic structure of the East African rift system: implications for magmatism, seismic hazard, and geothermal energy potential

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A consensus has emerged over the last 20 years that mechanical plate stretching models for rifting are a poor fit for much of the East African rift: magma intrusion instead accommodates much of the plate separation, with little-to-no crustal thinning. This has important subsequent implications for seismic and volcanic hazard, and the viability of geothermal energy exploration within often-densely-populated rift valley regions. However, not all sectors of the East African rift operate in the same way. Magma-poor zones in the Turkana Depression, for example, contrast magma-rich ones further north (e.g., Bastow et al., 2010; Ogden et al., 2023; Kounoudis et al., 2023). A central challenge is therefore to identify areas of the East African crust that, although characterised by active volcanoes at the surface, are not underlain by well-developed, magma-rich and seismically active crustal fault and fracture networks.

This project will address this issue using a range of passive seismic monitoring techniques in both magma rich and magma poor rift sectors, including utilising datasets recently collected by the Imperial College group. Analysis of seismic ambient noise, surface waves, and local earthquake splitting will be used to constrain seismic anisotropy, which is strongly sensitive to melt and the extent of fracturing of the crust. Concurrent analysis of seismicity data along the rift using cutting-edge machine-learning methods, can provide further constraint on the depth and spatial extent of fluid-rich crustal fault and fracture networks. Analysis of bulk crustal structure using receiver function analysis will also help place constraints on the extent of magmatic modification (Ogden et al., 2019).

The person tackling this project should have a keen interest in seismic and tectonic processes (ideally a background in geophysics or physics). A keenness to synthesise findings in the context of hazard and resource management would also be welcomed and to this end, the studentship will provide the opportunity to engage with collaborators in Ethiopia.

References:

Bastow, I. D., et al., (2010), Melt-induced seismic anisotropy and magma assisted rifting in Ethiopia…, G3, 11, Q0AB05, doi:10.1029/2010GC003036.

Kounoudis, R., et al., (2021), The development of rifting and magmatism in the multiply-rifted Turkana Depression, east Africa…, EPSL, doi:10.1016/j.epsl.2023.118386.

Mousavi, S., et al., (2020), Earthquake transformer—an attentive deep-learning model for simultaneous earthquake detection and phase picking, N. Comm., 11(1), doi:10.1038/s41467-020-17591-w.

Ogden, C., et al., (2019), A Reappraisal of the H-κ Stacking Technique…, GJI, 219 (3), doi:10.1093/gji/ggz364.

Ogden, C., et al., (2023), The development of multiple phases of superposed rifting in the Turkana Depression, East Africa…, EPSL, 609, 118,088, doi:10.1016/j.epsl.2023.118088.