Testing the upper-mantle seismic signature of plume-lithosphere interaction in the northern East-African Rift

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Introduction

Below the northern East African Rift two low seismic velocity zones are imaged. **Are these due to the rising thermal anomalies?** We will explore this hypothesis by generating synthetic tomography from models of the convective destabilisation of hot mantle.

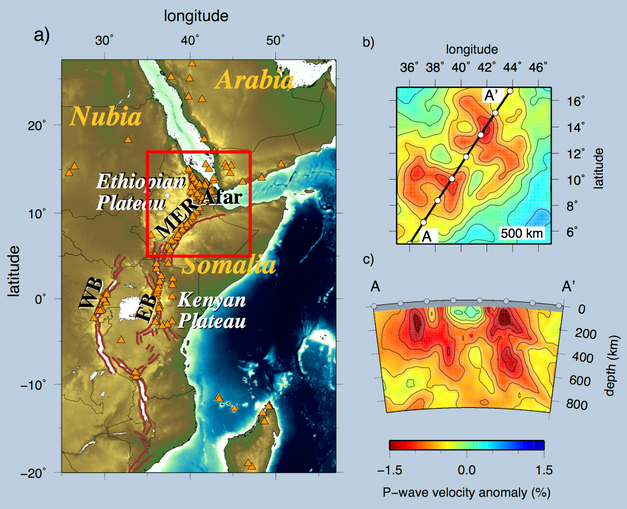

Figure 1: The northern East African Rift and slices from the P-wave tomographic model NEAR-P15 [1].

Geodynamics to Seismics

Both Rayleigh Bénard convection and Rayleigh Taylor instabilites are generated using by solving for modified Stokes flow in a Cartesian box using the code Stag3D [5]. Temperature and pressure are converted to mineral phases assuming a pyrolite composition for the mantle and harzbugite for the lithosphere. This gives the anharmonic seismic velocity. This is corrected for attenuation using the Q_g model [3].

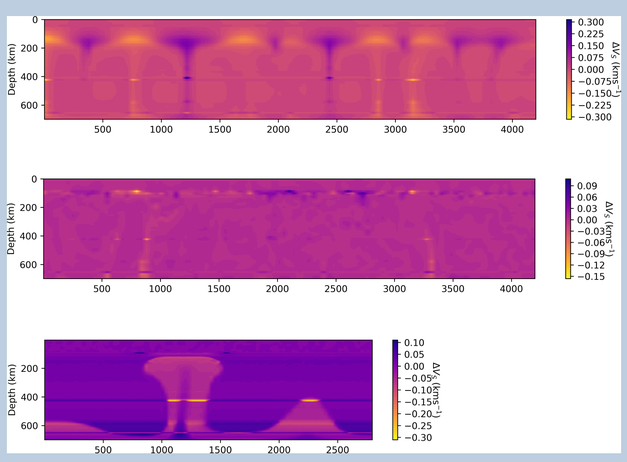

Figure 2: 2D slices through the model domains for Rayleigh Bénard convection with a Newtonian rheology, a non-Newtonian rheology, and the Rayleigh Taylor destabilisation of a hot layer.

To Cut a Long Story Short

1. Only the destabilisation of a hot layer is consistent with the mangitude of the observed low seismic anomalies.
2. The spacing of the anomalies are consistent with a hot layer roughly 20,000 km wide.
3. The magnitude of the seismic velocities are consistent a 200 °C thermal anomaly.

References

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[3] S. Goes et al. Low seismic velocities below mid-ocean .... *Journal of Geophysical Research*, 117:B12403, 2012. doi: 10.1029/2012JB009637.

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Rayleigh Bénard or Taylor?

For Raleigh Bénard (RB) convection the wavelength between plumes, λ, varies as $Ra^{1/6}$ [2]. For Raleigh Taylor (RT) destabilisation of a hot layer, λ, varies as a linear function of the model height [4]. The observed spacing of the two low seismic velocity structures is ~ 700 km (Figure 1). We find that for RB convection this implies a $10^6 < Ra 10^7$. For RT destabilisation this is consistent with a model aspect ratio of $2,1000 \times 2,100 \times 700$ km.

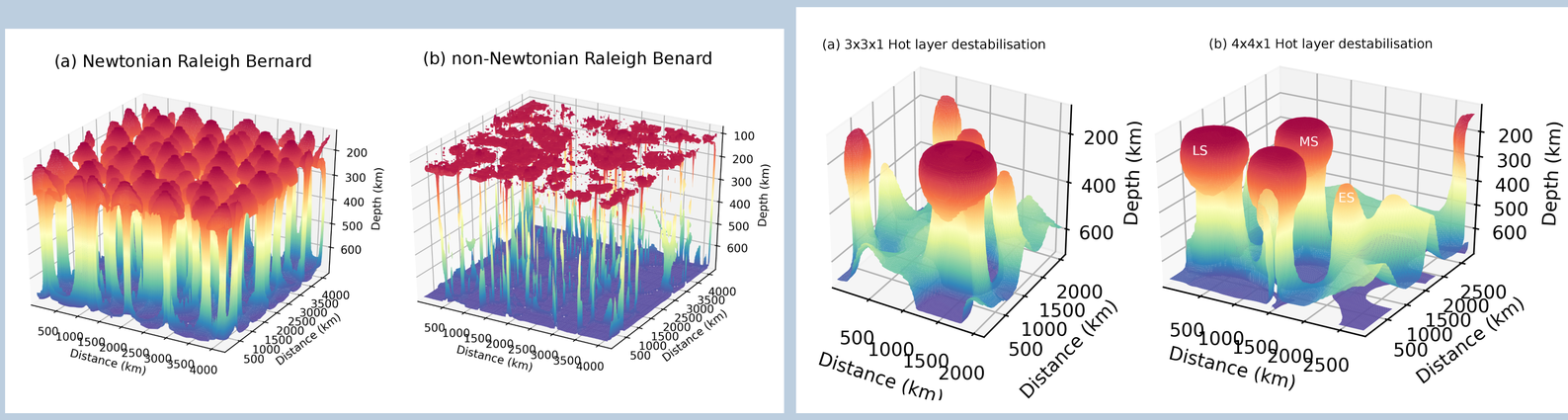

Figure 3: Figure caption 1 (left); Figure caption 2 (right)

Results Heading 2

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Figure 4: Figure caption 1 (left); Figure caption 2 (right)