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Full seismic waveform inversion of the African crust and Mantle – Initial Results

Michael Afanasiev (1), Laura Ermert (1), Myrna Staring (2), Jeannot Trampert (3), and Andreas Fichtner (1)

(1) Institut für Geophysik, Department of Earth Science, ETH Zürich, Zurich, Switzerland (michael.afanasiev@erdw.ethz.ch), (2) Department of Geoscience and Engineering, Delft University of Technology, Delft, The Netherlands, (3) Department of Earth Sciences, Universiteit Utrecht, Utrecht, The Netherlands

We report on the progress of a continental-scale full-waveform inversion (FWI) of Africa. From a geodynamic perspective, Africa presents an especially interesting case. This interest stems from the presence of several anomalous features such as a triple junction in the Afar region, a broad region of high topography to the south, and several smaller surface expressions such as the Cameroon Volcanic Line and Congo Basin. The mechanisms behind these anomalies are not fully clear, and debate on their origin spans causative mechanisms from isostatic forcing, to the influence of localized asthenospheric upwelling, to the presence of deep mantle plumes. As well, the connection of these features to the African LLSVP is uncertain.

Tomographic images of Africa present unique challenges due to uneven station coverage: while tectonically active areas such as the Afar rift are well sampled, much of the continent exhibits a severe dearth of seismic stations. As well, while mostly surrounded by tectonically active spreading plate boundaries (a fact which contributes to the difficulties in explaining the South's high topography), sizeable seismic events (M > 5) in the continent's interior are relatively rare.

To deal with these issues, we present a combined earthquake and ambient noise full-waveform inversion of Africa. The noise component serves to boost near-surface sensitivity, and aids in mitigating issues related to the sparse source / station coverage. The earthquake component, which includes local and teleseismic sources, aims to better resolve deeper structure. This component also has the added benefit of being especially useful in the search for mantle plumes: synthetic tests have shown that the subtle scattering of elastic waves off mantle plumes makes the plumes an ideal target for FWI [1]. We hope that this new model presents a fresh high-resolution image of sub-African geodynamic structure, and helps advance the debate regarding the causative mechanisms of its surface anomalies.

[1] Rickers, F., Fichtner, A., and Trampert, J., 2013. The Iceland–Jan Mayen plume system and its impact on mantle dynamics in the North Atlantic region: Evidence from full-waveform inversion, Earth and Planetary Science Letters, 367, 39-51.