Azimuthal anisotropy of Rayleigh-wave phase velocities in Cameroon, West Africa.

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The Cameroon region contains several tectonic features of interest to earth scientists. One of these is a chain of intra-plate volcanic line (CVL) without age progression. Since the CVL defies common geodynamic explanations, its origin has been subjected to considerable debate without reaching a consensus. Therefore, to advance understanding of the deformation and flow patterns resulting from the CVL and other tectonic processes in Cameroon, we imaged the azimuthal anisotropy of Rayleigh wave phase velocities from 4 to 60 seconds.

The seismic data used for this study was retrieved from both ambient seismic noise records and teleseismic earthquake data recorded by 32 broadband seismic stations deployed during the lifetime of the Cameroon Broadband Seismic Experiment (CBSE). First, we analyzed vertical component seismograms for 310 earthquakes with magnitude 5.0 occurring between the distances of 30^0 to 90^0. The traditional two-station method is adopted for measuring the inter-station phase velocities. Secondly, we processed continuous records of ambient seismic noise data from January to December 2006 following the method detailed in Ojo et al. (2017). For each inter-station path, we measured the phase velocity using the frequency-time analysis method. Following Yao et al. (2008), we averaged the dispersion from both datasets for similar station pairs by effectively weighting up earthquake measurements at long periods and ambient noise measurements at short periods. We eliminated erroneous phase velocity data that lay outside 2σ and those that did not meet the one wavelength criteria. Finally, we used the continuous Tarantola inversion program to obtain 2-D isotropic phase velocity and azimuthal anisotropy (amplitude and fast direction) maps from the path-averaged dispersion at each period.

The results revealed an obvious stratified azimuthal anisotropy beneath the Adamawa Plateau and Garuoa Rift (Northern part of CVL). The fast direction changes from NE–SW in the period band of 4-30s to NW-SE at longer periods which correspond to deeper depths. The distinct pattern of azimuthal anisotropy at short and long periods implies that the deformation varies with depth. Hence, we proposed a layered mechanism of deformation with almost independent processes at shorter and longer periods resulting from both frozen-in and present sources. This may also reflect decoupling of deformation or successive deformation episodes recorded at different depths. A consistent NE-SW fast direction is found at most period band beneath the Congo Craton. However, at around 38-44s a transition zone (probably indicative of the Moho) with N-S fast direction is revealed. This observation suggests a frozen-in anisotropy related to the NE-ward movement of the asthenosphere relative to the African plate. Along the southern part of the CVL, the fast direction trends N-S at short periods and changes to NNE-SSW at longer periods. We interpret this as first-order evidence for dominated northward and upward flow of plume materials associated with magma intrusion. The direction of fast axis beneath the Oubanguides Belt is largely NE-SW. This direction is parallel to the strike direction of known strike-slip faults in the study area, suggesting a lithospheric origin for the observed azimuthal anisotropy.

Our results provide new evidence for the existence of small-scale convection in the asthenosphere related to the formation of the CVL and help constrain the source region of previous shear wave splitting studies in the study area.

References

Ojo, A. O., Ni, S. and Li, Z., 2017. Crustal radial anisotropy beneath Cameroon from ambient noise tomography. Tectonophysics 696–697, 37–51.

Yao, H., Beghein, C., and Van der Hilst, R.D., 2008. Surface-wave array tomography in SE Tibet from ambient seismic noise and two-station analysis: II - Crustal and upper mantle structure. Geophys. J. Int., 173 (1), 205-219.

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