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Probing for Shear Wave Anisotropy in the Lowermost Mantle Beneath the Atlantic and Indian Oceans

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In this study, we explore the existence, strength, orientation, and location of shear wave anisotropy within the deepest 100-300 km of the mantle known as D''. We utilize shear phases (teleseismic S and Sdiff) that sample areas near the core-mantle boundary (CMB), providing unique information about the structure of the CMB region. Seismic analysis of D'' can help constrain structure and flow at the base of the mantle, core-mantle interactions, and the style of mantle convection near the CMB.

Waveforms used in this study were recorded by the Kaapvaal Seismic Array, a two-year deployment of over 80 broadband stations in South Africa, Zimbabwe, and Botswana. The array was one component of a multidisciplinary project conducted by the Carnegie Institution of Washington, MIT, and several southern African academic institutions and industry collaborators. Instrumentation was obtained from the IRIS/PASSCAL and Carnegie Institution of Washington seismometer pools, and data from several IRIS/GSN permanent stations provided supplemental data near the array. The full array recorded numerous teleseisms from events originating in South American and western Pacific subduction zones, and densely sample regions of D'' beneath the Atlantic and Indian Oceans. To reduce the effects of source-side upper mantle anisotropy, we use waveforms from deep-focus events (>400 km). The configuration of closely-spaced stations enables us to utilize cross-correlation techniques to evaluate the dataset, which provides a more objective analysis of the character of splitting. This study is the first high-resolution analysis of D'' anisotropy for these regions.

We have calculated differential travel times between the radial and transverse components of S (SV-SH) and Sdiff (SVdiff-SHdiff). Preliminary analyses indicate that apparent splitting for paths traversing beneath the Atlantic is relatively small (~1.5 sec and less), but that SH consistently arrives before SV. Corrections to individual waveforms for the effects of receiver-side upper mantle anisotropy reduce S/Sdiff splitting times by 0.5 sec or less, suggesting that well-resolved splitting of ~1.0 sec due to lowermost mantle structure is likely present in this region.

To provide additional constraints on D'' anisotropy in these regions, we will augment our dataset with waveforms from several nearby regional broadband arrays, including the Tanzania Broadband Seismic Experiment and the Saudi Arabian Portable Broadband Deployment. The geometry of these complementary arrays will allow us to provide a more complete picture of the character of lowermost mantle anisotropy beneath the Atlantic and Indian Oceans.