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Analysis of upper mantle seismic anisotropy beneath the Borborema Province based on XKS wave splitting measurements

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The Borborema Province (BORB), located in northeastern Brazil, is a Neoproterozoic orogenic belt on a continental margin that exhibits distinctive geological and geophysical features, such as intense neotectonic activity, elevated heat flow, and significant intraplate seismicity. Despite substantial advances in understanding its tectonic evolution, uncertainties remain regarding the origin and depth of the seismic anisotropy observed in the region, often attributed to processes such as lithospheric delamination, asthenospheric flow, or reactivation of transcurrent shear zones. In this study, we analyze XKS shear-wave splitting data to investigate the anisotropic patterns in the BORB and discuss their relationship with the lithospheric structure and ongoing geodynamic processes. Seismic anisotropy in the upper mantle is generally attributed to the lattice-preferred orientation of olivine, induced by deformation processes or mantle flow. This anisotropy causes shear waves to split into two orthogonal components: a fast wave polarized along the fabric direction and a delayed slow wave (delay time δt). The Silver and Chan (1991) method, widely applied to determine the fast polarization direction (Φ) and delay time, is based on minimizing energy on the transverse component of SKS phases. After rotation of the horizontal components into the radial-transverse system, a grid search over candidate (Φ, δt) pairs is conducted by applying inverse splitting corrections. For each pair, the residual energy on the transverse component is computed, and the optimal solution is that which minimizes this energy, effectively removing the anisotropic signature. The method assumes near-vertical incidence, a single horizontal anisotropic layer, and identical fast and slow waveforms. Here, we employ the SplitRacer algorithm (Reiss and Rümpker, 2017), which includes automatic window selection, uncertainty estimation following Walsh et al. (2014), and efficient processing of large datasets, such as those from the BORB seismic stations. Preliminary interpretations of shear-wave splitting measurements across the Borborema Province suggest the presence of complex upper mantle anisotropy, marked by significant spatial variations in fast polarization directions and delay times. The observed patterns likely reflect the combined effects of fossil lithospheric fabric, inherited from Precambrian tectonic episodes, and asthenospheric flow influenced by the surrounding cratonic keels. Fast polarization directions show notable alignment with the main structural trends of the province, including major shear zones, while deviations from these trends may indicate deeper, sub-lithospheric contributions. These findings are consistent with previous studies that interpret anisotropic signatures in the region as the result of both lithospheric inheritance and dynamic asthenospheric processes, including flow around the São Francisco and Amazonian cratons. As data analysis progresses, more detailed mapping of anisotropy parameters will help constrain the relative contributions of these mechanisms, shedding light on the geodynamic evolution and current tectonic behavior of this complex intraplate setting.