Geophysical Research Abstracts
Vol. 21, EGU2019-9979, 2019
EGU General Assembly 2019

Seismic Anisotropy in Mid-Plate South America: an Updated Model Using Shear Wave Splitting Measurements and Waveform Tomography

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Seismic anisotropy beneath stable continental regions yields important information on their tectonic history and the patterns of upper mantle flow, in a way not achieved by other methods. We investigate the upper-mantle seismic anisotropy beneath South America using a suite of complementary data and models, including shear wave splitting (SWS) and the isotropic and azimuthally anisotropic shear-velocity distributions in the upper mantle from waveform tomography. SWS at individual stations, from core refracted phases (such as SKS phases), indicates the amount and orientation of the seismic anisotropy in the upper mantle, and shows excellent lateral resolution. These measurements can be compared to surface wave velocities and azimuthal anisotropy, for a better understanding of the distribution of anisotropy with depth, and in different tectonic settings.

Previous studies of SWS in South America concentrated mainly along the Andes and in southeast Brazil. Here, we add extra measurements extending to the entire Brazilian territory, including the Amazon area, and the Pantanal and Parana-Chaco basins, as part of the FAPESP "3-Basins Thematic Project". The results from both temporary deployments and the Brazilian permanent network provide a more complete and robust anisotropy map of the South America's stable core than available previously.

We observe, in general, little correlation of the anisotropy directions with geological trends and a better match with the absolute plate motion (APM) directions, mainly E-W. This indicates that the observed anisotropy is mainly due to the upper-mantle flow, with little contribution from frozen lithospheric anisotropy. Notable deviations from the APM directions appear to be due to flow surrounding cratonic nuclei: the keel of the São Francisco craton, a possible cratonic nucleus beneath the northern part of the Paraná Basin (the Paranapanema block) and, in the north, the Amazon craton. Large delay times at the Pantanal Basin may indicate a stronger asthenospheric channel, a more coherent flow, or a thicker asthenosphere. Small delays beneath the northern Paraná Basin may indicate thinner anisotropic asthenosphere beneath the thick Paranapanema block or a reduction in the amount of SWS due to anisotropy with different fast azimuths in the asthenosphere and lithosphere.