Comparing crustal Rayleigh and Love wave phase velocities beneath the Paraguay, Brasília, and Ribeira fold belts

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Abstract

Opposed to cratons, fold belts are regions of continental lithosphere that were significantly affected by tectono-magmatic events during the course of Earth's history, and as such are less stable areas characterized by higher heat flux, weaker rheology, and thinner lithosphere. In this study, we use data from seismic stations placed in the region of the Tocantins Province (Central Brazil) and neighboring areas to derive and compare phase velocities for the crust beneath the Paraguay, Brasília, and Ribeira fold belts. We employ a usual ambient noise tomography scheme, where we first cross-correlate long continuous recordings between pairs of stations to extract their Green’s function, which allows us to estimate surface wave dispersion curves as if one station acted as a source. Then, the next step is to perform 2D surface wave tomography in order to distinguish the velocity contributions of each tectonic unit, and here we iteratively apply a fast marching and a subspace method, which already provided robust distributions of seismic velocities worldwide. Because Rayleigh and Love waves are a function of vertically and horizontally polarized shear-waves, respectively, estimating the distribution of both might shed some light on the anisotropy structure beneath the study region. We use regionalized frequency-dependent Rayleigh and Love wave phase velocity maps as a proxy to shear-wave velocity distribution; as these maps are restricted to the period range 5-40 s, they are much more affected by crustal and uppermost mantle material than by deeper material. The maps exhibit an excellent correlation with surface geology. On the short period (5-20 s) Rayleigh and Love wave maps, the Paraguay, Brasília, and Ribeira fold belts are generally characterized by fast velocities due to the presence of exposed crystalline basement in the Tocantins and Mantiqueira provinces, instead of loosely packed sediments. An exception is the northern portion of the Paraná basin, where the maps show slow velocities probably due to the sedimentary cover. A clear velocity contrast clearly marks the gravity-derived Western Paraná Suture, especially in the Love wave phase maps. For 30 and 40 s period Rayleigh waves, the fastest velocities are mapped beneath the northern Brasília belt, where a linear velocity structure seems to be related to the Transbrasiliano Lineament; for the other belts, velocities are slightly slower. 30 and 40 s period Love waves present a similar behavior, but we can observe some slow velocity structures beneath the Ribeira and Paraguay belts that are not seen in the Rayleigh wave maps, which might suggest a difference between Sv and Sh distribution.