Study of the lithosphere under Brazil using multiple frequency seismic tomography with S-waves

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Abstract

The main objective of this work is to use S-wave Multiple Frequency Seismic Tomography to obtain images, with higher spatial resolution, of the velocity anomalies in the lithosphere and in the sublithospheric mantle under Brazil, covering regions that have not yet been studied by this method. For the purposes of quality control of seismological data, P-wave Particle Motion Analysis was used to identify stations with orientation errors that could, ultimately, affect the computation of the relative time residuals necessary for the tomographic inversion. The orientation errors of 156 seismometers were estimated, of which 17 had absolute errors greater than 10º. Only for the BOAV station (subnet BR-UnB) an orientation error greater than ±90º (+177.5°) was estimated. This analysis also allowed the identification of the cause of orientation errors. With the exception of BOAV, installed with the North-South components inverted, orientation errors were mainly caused by incorrect compass declination. In order to verify the influence of geology on the azimuthal deviation values, statistical tests were performed comparing groups of stations installed in two types of geological environments. The results indicated that the stations located in Pre-Cambrian Basement tend to generate more accurate azimuthal deviation values compared to those located in Phanerozoic Covers. After correcting the orientation, based on the estimated errors, the data was cross-correlated to obtain the time residuals that were later used in the tomographic inversion. This, in turn, generated the maps and profiles of S-wave velocity anomalies at different depths, with significantly better resolution than the models found in the literature, especially when compared with works that used the Geometric Ray Theory as a basis. These results allowed to improve the current knowledge and raise discussions about several aspects of the observed velocity anomalies and their interpretation within the context of each Brazilian Structural Province. From the maps and profiles, it was possible to identify high-velocity anomalies related to the cratonic blocks of the Paraná Basin (Paranapanema Block), the Amazonian Craton, the São Francisco Craton and the Parnaíba Basin (São Luís Craton). Low-velocity anomalies, on the other hand, are related to suture and lithospheric thinning zones. The seismicity recorded in the Tocantins Province also follows the contours of low-velocity anomalies in this region, which may be a consequence of the existence of weakness zones resulting from the lithospheric thinning with the rise of the warmer asthenosphere. Such thinning makes the compressive stress that acts on the South American Plate concentrate on the crust, generating faults or reactivating old ones.