Seismic anisotropy analysis of the upper mantle under Brazil from XKS wave splitting measurements

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Abstract

Since the 1960s, seismic anisotropy has been used as a tool for studying deformations in the upper mantle, because anisotropy is a direct consequence of the stress processes, which occur inside the Earth. Still, information about the occurrence and character of anisotropy also allows us to determine the asthenospheric flow induced by the movement of lithospheric plates. One of the clearest manifestations of seismic anisotropy takes place with the splitting of a shear wave, a phenomenon analogous to the optical birefringence of minerals under polarized light. For a seismic ray arriving almost vertically at a station, the parameters related to this division of the shear wave, ϕ (the polarization direction of the fastest pulse), and δt (the time difference between the fastest and the slowest pulse), are obtained from the analysis of seismograms that are recorded by seismic stations. Commonly, for studies of seismic anisotropy in the upper mantle, the so-called refracted phases in the core (XKS) are used, such as SKS, SKKS, PKS, and PKKS, because the initial polarization of this shear wave is controlled by the conversion of the P wave to the S wave in the mantle-core boundary, and is therefore known. In the absence of an anisotropic layer, the core phases are assumed to arrive at a seismic station with energy only in the radial component. In southeastern Brazil, previous XKS results show both a strong correlation between the faster anisotropic polarization directions and the orientation of geological faults and asthenospheric flow around cratonic keels and an average E-W orientation that coincides approximately with the South American plate movement direction provided by the HS3-NUVEL-1 reference model. The seismic station distribution in Brazil has been improving since 2011, with the installation of new stations that now make up the Brazilian Seismographic Network (RSBR). Thus, in this project, to obtain an updated seismic anisotropy model, we will carry out new measurements of XKS-wave splitting in all stations of the RSBR, using the method of transversal component minimization. We will investigate the potential mechanical coupling between the crust and the uppermost mantle in a structurally complex region, which encompasses a wide variety of geological structures, such as cratonic roots, orogenic belts, magmatic provinces, and sedimentary basins, so that new constraints on geodynamic processes responsible for the current geological scenario in this part of South America can be obtained.