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Rayleigh-wave Tomography and Seismic Anisotropic Structures in the Region of the Philippine Sea

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The Philippine Sea Plate (PSP) is surrounded by convergent boundaries, the Pacific plate is subducting beneath the PSP along the Izu-Bonin and Mariana trenches at the east, whereas the PSP is subducting beneath the Eurasian plate along the Nankai trough, Ryukyu trench and Philippine trench at the west. The PSP can be divided by three oceanic basins: the oldest West Philippine basin developing in 35-45 Ma in the west, and the Shikoku and Parece Vela basins in 15-30 Ma in the east. Previous studies show a large variety of the seismic anisotropy structures in the region of the PSP, which correspond different scenarios of tectonic evolution for this area.

In this study, we analyze both isotropic and anisotropic Rayleigh-wave velocity structures of the PSP by means of two-station method. The earthquakes of magnitude (Mw) greater than 5.0 in-between the years 1998-2014 were acquired. Totally, 7914 teleseismic events are adopted to form the measurements of Rayleigh-wave dispersion curves along 467 station-pairs over the PSP. The measured dispersion curves are then inverted into the isotropic and azimuthally anisotropic (2ψ) velocity maps at different periods with the damped, lateral smoothing LSQR inversion. The inversion is framed by the triangular grids which knots are of 200 km spacing. The consequent velocity anomalies are referenced to the average of the phase velocity at the periods between 50 and 100 seconds.

The resulting velocity anomalies show a consistent pattern with the locations of the sub-basins in the PSP at the periods of 50 and 60 sec, which can be considered to be the association of lithospheric velocity structure with basin ages. The positive velocity anomalies are seen in the West Philippine basin associating the relatively old lithosphere; whereas the negative anomalies are found in the Shikoku and Parece Vela basins which the lithospheric structures are relatively young. On the other hand, the resultant azimuthal anisotropy reveals an apparent trench-parallel pattern in the northern half of the PSP. Such a trench-parallel pattern may reflect to the lateral flow of the upper mantle subject to the southward retreating of the PSP at the Ryukyu trench. The amplitude of anisotropy in the south half of the PSP is relatively minor. It is found to follow the direction of the plate motion as the PSP converging to the Eurasian plate. A distinct weak anisotropy is shown in the south-east PSP, where is just next to the Mariana trough as well as the Mariana trench. The undergoing back-arc spreading in the Mariana trough and the high-angle subducting of the Pacific plate at the Mariana trench may drive a complicated mantle flow in that area.