Azimuthal anisotropy in the lowermost mantle beneath Philippine from ScS-S times

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Introduction: Seismic anisotropy in the lowermost mantle has been detected by splitting of diffracted S and ScS phases, the discrepancy of shear wave splitting of SKS and SKKS, to date. In many cases, the propagation direction of such seismic waves is restricted due to the combination of sources and receivers. Thus, the azimuthal anisotropy using ray paths passing in multi-directions has been rarely discussed. Now, seismic networks and large-scale seismic arrays have been increasing especially in the eastern Asia where there are also many earthquakes. It is a good opportunity to examine an azimuthal variation of travel times passing through the outside of the Pacific Large Low Shear Velocity Province, where the existence of anisotropy in the lowermost mantle is expected.

Data and Method: I used the seismograms of earthquakes occurred in Mariana, east China, Indonesia, and Vanuatu that are record with the seismic stations belonging to IRIS GSN and PASSCAL, Thai Metrological Department, F-net, JISNET, NECESSArray. This geometry gives a good condition that the mid-points of seismic ray paths are located near Philippine with various azimuths.I measured ScS–S differential travel times using a waveform cross-correlation method, which can effectively cancel the heterogeneity in the crust and upper mantle and the uncertainty of hypocenters. The differential travel times are compared with theoretical travel times by PREM with correction of physical dispersion due to anelasticity for the typical period of 10 s, that for ellipticity of the Earth, finally I obtained about 500 residuals. Even though I used the differential travel times, the ScS–S residuals show the large scattering and the correlation with the residuals of S travel times are much larger than that of ScS phases. This means that the raw ScS–S residuals are affected by heterogeneity in the upper part of the lower mantle where only S waves are propagated. Thus, we applied the further corrections using 3D mantle heterogeneity models.

Results and Discussion: We used S-wave 3D models of S16U6L8, S4BL16, S40RTS, SEMUCB-WM, and a P-wave 3D model of GAP-P4 with conversion rate dlnVs/dlnVp=1.7. I found that the scatter of the ScS–S residuals are much improved and that the correlation coefficient between the residuals of ScS–S and ScS are increased and that between ScS–S and S are much reduced when the GAP-P4 model are used for the correction, probably due to its high spatial resolution in the upper lower mantle. As a result, only the ScS–S residuals corrected with the modified GAP-P4 can be used to infer seismic anisotropy in the lowermost mantle.

Then I fitted cos 2qand cos 4qcurves with least square to obtain the characteristics of the azimuthal variation of the ScS–S residuals, clearly indicating that cos 2qcomponent is significant with the fastest direction (the minimum ScS–S) is along ESE-WNW (N110°E). This can be explained if [100] axis of post-perovskite is oriented vertically and the direction of [001] axis is ESE-WNW for the incident angle of 45°. The S-wave fastest direction is nearly parallel to the plate motion directions of the Philippine Sea plate and Sunda block. The amplitude of the azimuthal variation in the ScS–S residual is ±1.1 s, which corresponds to 1.7 % anisotropy if we assume the D”　thickness of 300 km based on the previous studies on the D”　discontinuity.

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