Abnormal Seismic Anisotropy beneath the Tokyo Metropolitan Area (1) Mantle of the Philippine Sea Slab

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1. Introduction

The Tokyo metropolitan area is located on a unique convergence zone associated with the North American (NA) plate: beneath the metropolitan area, dual subduction system was formed by the Pacific (PAC) and Philippine Sea (PHS) plates. Furthermore, subduction of the PHS slab brings a collision zone between the NA plate and the Izu-Ogasawara islands arc, which is on the PHS slab, in the vicinity of the metropolitan area. Therefore, the metropolitan area is seismically active and has various types of earthquakes. However, the relationship between the configuration of plates (the NA, PAC, and PHS plates) and the seismicity remains unknown, although seismo-tectonics of the region has been studied from the various points of view, such as earthquake mechanism, hypocenter distribution, and seismic velocity structure. Thus, we focus on seismic anisotropy that could provide useful information on dynamics and tectonic. In this study, we investigate the three-dimensional (3D) structure of P-wave azimuthal anisotropy beneath the Tokyo metropolitan area.

2. Data and Method

The modeling space is the Tokyo metropolitan area (34.7 - 36.8°N, 138.5 - 141.5°E, 0 - 150 km). In order to determine 3D P-wave azimuthal anisotropy velocity structure, seismic anisotropy tomography method of Ishise and Oda [2008] was applied to 442960 P wave arrival time data from 1859 local earthquakes recorded at 500 seismic stations, including 296 Meso-net stations. Initial source parameters (location and origin time of earthquake) used in this analysis were determined independently by NIED. The 3D velocity structure in the modeling space is described by velocity parameters assigned to a 3D grid structure. The grid structure was composed of 0.1° - 0.2° grid spacing in the latitude and longitude directions. In the vertical direction, grid nodes were spaced at 5 - 20 km.

3. Results

As a result of the tomographic analysis, we found a unique anisotropy region in the lower edge of the PHS slab mantle, or rather the contact zone between the PHS and PAC slabs. The region has strong anisotropy, and the fast axes are uniformly oriented in the N-S trending direction. Generally, anisotropy in the slab can be explained by lattice preferred orientation of mantle minerals or alignments of cracks and faults. However, any mechanism cannot explain the N-S trending anisotropy in the PHS slab beneath the study area. It might suggest that the modeling under the assumption of azimuthal anisotropy would be inappropriate for the study area. Alternatively, it is possible that we have to change our basic idea of the subduction zone.

Acknowledgments: We used Hi-net seismological data. This study was supported by the Tokyo metropolitan project.

Keywords: seismic anisotropy tomography, Tokyo metropolitan area, Philippine Sea slab, Pacific slab

