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Converted waves observed by the MeSO-net for earthquakes below the Boso Peninsula, central Japan

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Various interplate phenomena, the largest aftershock (M7.6) of the 1923 Kanto earthquake, repeating earthquakes, and slow slip events which repeat every 6-7 years have occurred off the Boso Peninsula, central Japan. To reveal generation mechanism of these events, knowledge about the plate structure is important. Converted waves are often observed between P and S arrivals for earthquakes off the Boso Peninsula. Detailed examination of numerous seismograms and seismic survey revealed that they are converted waves (hereinafter, X-phase) excited at the volcaniclastic rocks layer (hereinafter, VCR-layer) distributed over the subducting Philippine Sea plate (PHS) (Kimura, 2005). Recently, dense seismographic network, called 'MeSO-net', has been under construction at the Tokyo metropolitan area. Converted waves were also observed by the MeSO-net (Sakai et al., 2008). In this study, we studied seismograms of the MeSO-net in more detail and compared them with the previous study. We mainly used a dense array along the Boso Peninsula (hereinafter, the Boso array).

For earthquakes below the Boso Peninsula, the following phases were observed by the Boso array. For interplate earthquakes on the PHS, coherent later phases were observed in the vertical component 1.8 - 2.4 s before the direct S wave (hereinafter, y1). For deeper earthquakes, coherent later phases were observed 1.8 - 2.5 s and 4.8 - 7.0 s before the S wave (hereinafter, y2 and y3, respectively). In either case, traveltime differences from the S wave do not change largely according to hypocenters and the apparent velocity are almost the same with the S wave. In radial component, later phases were observed 1.8 - 3.8 s after the direct P wave for earthquakes deeper than the interplate earthquakes (hereinafter, z1).

To reveal origin of converted waves, we calculated traveltimes by using finite difference method developed by Zelt and Barton (1998). The velocity structure was made after the structure which is routinely used in Hi-net and we adopted the VCR-layer revealed by seismic reflection survey (Kimura, 2005; Kimura et al., 2009). We estimated Vp and Vs of the surface sedimentary layer as 1.9 and 0.7 km/s respectively (Vp/Vs ratio, 2.7), by comparing arrival times between the shallow station of the Boso array (E.DD15; sensor elevation, 75m) and the nearby deep Hi-net station (N.YROH; sensor elevation, -1920m; 2.3km away from E.DD15). We used depths of sedimentary basement of Hayashi et al. (2006) along the Boso array and extended it in the E-W direction. In the following, we compared traveltime differences between the PS converted waves and the direct S wave or the SP converted waves and the direct P wave with observations because traveltimes through surface layer can be cancelled out.

Most of traveltimes of the SP converted wave at the basement, the SP converted wave at the VCR-layer, and the PS converted wave at the VCR-layer coincide with traveltimes of y1 and y2, y3, and z1, respectively, within 0.6 s. Supposing that z1 corresponds to the X-phase of Kimura (2005) and y3 corresponds to the SP converted wave at the same boundary, traveltimes and dominant components can be explained well. This is consistent with the fact that y3 cannot be seen for interplate earthquakes and is observed only for earthquakes deeper than interplate earthquakes. Due to thick sediment, hypocenter error can be large and hypocenter error can cause differences between synthetic and observed traveltimes and hence further examination is necessary. We can expect new information about plate boundary structure from further analysis of converted waves.

Keywords: Kanto, MeSO-net, converted wave, plate boundary, sedimentary basin