Spatial distribution of reflection intensity on the upper surface of the Philippine Sea Plate, off the Boso Peninsula, Japan

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Abstract

The region off the Boso Peninsula, Japan, is one of the most complex tectonic setting areas in the world. The Pacific plate (PAC) is subducting westward beneath the landward plate and the Philippine Sea plate (PHS) from the Japan trench, while the PHS is subducting northwestward under the landward plate from the Sagami trough. These tectonic interactions have caused various seismic events such as the Taisho and Genroku Kanto earthquakes and the Boso Slow Slip Events (SSEs). To better understand these seismic events, it is important to determine the structure under this region.

Many studies have conducted active and passive seismic experiments off the Boso Peninsula. These studies estimated the depth of the upper surface of the PHS (UPHS) in the area. Meanwhile, several active seismic experiment studies suggested that intensity of reflections along the UPHS varies with depth, and relatively strong reflections have been observed in the main slip area of the Boso SSEs. The variation of reflection intensity along the plate boundary is also seen in other subduction zones. For example, an inverse relationship between the seismicity and the reflection intensity has been observed in the region off the Tohoku district. To explain this inverse relationship, a thin low velocity structure composed of low frictional coefficient materials along the plate boundary has been proposed. These results from previous studies suggested that the strong reflection along the UPHS may be related to the Boso SSEs.

Although there may be a relation between the strong reflection area and the Boso SSEs, spatial distribution of the reflection intensity along the UPHS is still unknown. Previous active seismic experiment studies have estimated only the 2-D seismic velocity structures and the reflection intensity along the 2-D profiles. In order to reveal the relation between the reflection intensity along the UPHS and the Boso SSEs precisely, it is important to estimate the spatial distribution of the reflection intensity in

the region off the Boso Peninsula.

A marine seismic experiment was conducted using airguns as a source off the Boso Peninsula from July to August 2009, to estimate 3-D P-wave velocity structure and spatial distribution of reflection intensity. Airguns were shot along the 4 survey lines, and 27 Ocean Bottom Seismometers (OBSs) were deployed in the survey area. In this study, I set the model range of velocity structure as 150 × 90 km, using 18 OBSs for the analysis.

A 3-D P-wave velocity structure was estimated from the first arrival traveltimes picked from the 18 OBS records. I also picked the reflection traveltimes, and applied them to the traveltime mapping method which estimates the locations of reflectors by projecting the reflection traveltimes to depth-distance domain. This is the first application of the method to the 3-D velocity structure, and I estimated the spatial distribution of the reflection intensity along the UPHS.

Consequently, many strong reflections from the UPHS were observed near the main slip area of the Boso SSEs and the eastern part of the model. Because any large velocity contrast could not be recognized near the UPHS in and around the slip area of the Boso SSEs, the strong reflections may be generated by a thin low velocity layer along the UPHS. In contrast, a high velocity structure lies near the UPHS in the eastern reflective area. The strong reflections in the area may be generated by a large positive velocity contrast. Lithology which constitutes the high velocity structure near the UPHS is unknown; however, it may be composed of boninite which is often seen in the outer-arc highs in the Izu-Bonin arc or the partially serpentinized mantle formed under the Izu-Bonin arc or the gabbro ascended by the intraoceanic faults in the PHS.

Keywords: Philippine Sea Plate, Traveltime mapping, Ocean Bottom Seismometers (OBS), 3-D P-wave velocity structure, Boso Slow Slip Events (SSEs), Izu-Bonin-Mariana arc