

Seismic structure from the forearc region off Miyagi to the central part of Northern Honshu arc, Japan, revealed by onshore-offshore seismic experiment - II

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Northern Honshu, Japan is a typical island arc developed in a trench-arc-backarc basin system. The 2011 Tohoku-Oki Earthquake (Mw9.0), that occurred on the Japan Trench off the eastern shore of northern Honshu, generated enormous crustal deformations. The geometry and structure of the subducting Pacific Plate (PAC) and the overlying Northern Honshu arc are inevitably important to understand such crustal deformation and the process of earthquake occurrence. In the summer of 2019, an onshore-offshore integrated seismic survey was carried out along an 850 km long profile from Japan Trench to the Yamato bank, crossing the central part of the Northern Honshu (Sato et al., 2020). Seismic reflection image and velocity model along the onshore part of the survey line have been obtained (Sato et al., 2020, Iwasaki et al., 2021). Kurashimo et al. (2021), on the other hand, presented the tomography-derived velocity model from the forearc region off Miyagi to northern Honshu. In this study, however, the seismic structure of the forearc mantle wedge and the subducting PAC, which would provide important keys for understanding crustal deformation associated with large earthquakes, have not been resolved well because the travel-time analysis was done only for first arrival data. In the present study, we used all travel-time data of refracted and reflected waves from air-gun shots on the forearc side recorded on 1,667 receivers on the 160-km onshore profile line and 24 seismic stations deployed along this profile line. These receivers and seismic stations were equipped with 4.5 or 5 Hz vertical-component geophone and 1.0-Hz three-component seismometer, respectively. In the obtained seismic records, reflected waves from the uppermost mantle beneath the forearc region are recognized. Furthermore, we can identify clear reflections, probably from the top of the PAC. These phases are quite important to constrain the geometry of the forearc mantle wedge and the subducting PAC. In order to estimate the reflector depth that could provide a reasonable explanation for observed reflection times, we calculated the reflection travel times via a 3-D finite difference travel time algorithm [Hole & Zelt, 1995]. Analyzing these dense onshore-offshore seismic data, we obtained detailed configuration of the subducting PAC and the structure of overlying Northern Honshu arc beneath the forearc region. The mantle wedge corner is ~ 20 km deep beneath the forearc region off Miyagi and crustal thickness thickens toward the west. The top of the PAC can be traced to a depth of ~ 30 km. Beneath the Pacific coast, the Moho of the northern Honshu Arc is ~ 28 km deep.

Keywords: onshore-offshore seismic experiment, Northeast Japan Arc, crust and uppermost mantle structure