The crust and uppermost mantle structure across the central part of the NE Japan Arc revealed from the 2019 onshore seismic refraction/wide-angle reflection profiling - III

*Takaya IWASAKI[1], Hiroshi SATO[2,3], Eiji KURASHIMO[3], Hirokazu ISHIGE[4], Hidehiko SHIMIZU[5], Tatsuya ISHIYAMA[3], Takashi IIDAKA[6], Masanao SHINOHARA[3], Shinji KAWASAKI[4], Susumu ABE[4], Naoshi HIRATA[3]

1. Association for the Development of Earthquake Prediction, 2. Shizuoka University Center for Integrated Research and Education of Natural Hazards, 3. Earthquake Research Institute, the University of Tokyo, 4. JGI, Inc., 5. JOGMEC, 6. Interfaculty Initiative in Information Studies, the University of Tokyo

We constructed the whole crustal structure model across the NE Japan from an extensive onshore-offshore seismic expedition, which was undertaken in 2019 from the Yamato bank to the Japan Trench across the central part of the NE Japan arc (Sato et al., 2020a, b). Our main data were acquired on the 150-km long onshore seismic line extending from the Shonai Plain on the coast of the Sea of Japan to the eastern margin of the Kitakami Mountains on the Pacific coast.

First, we revised the previous crustal model by Iwasaki et al. (2021a,b; 2022) from the travel-time analysis using the ray-tracing technique. In the modelling for the crooked part of the profile, “the distance correction (Iwasaki et al., 2021a)” was applied to correct the systematic travel-time shifts arising from the ray-tracing calculation under the simple 2D assumption. This was quite effective, and revealed highly complicated sedimentary structure beneath the western and middle parts of the profile. The structure of lower crust and uppermost mantle were modelled from the first arrivals and later phases at far offsets (>50-60 km). To extract reliable structural information from weak wide-angle reflections, we applied the stacking method to the original seismic records, and carried out intensive travel-time analysis both for the original and stacked seismic sections.

Next, synthetic seismograms was computed based on the asymptotic ray theory. We also included the above-mentioned distance correction, and compared with the observed records. This amplitude calculation showed inadequateness of modelling only from the travel-time data, and could refine the geometry and velocity contrast at layer boundaries within the sedimentary part, and constrain several velocity discontinuities existing in the middle/lower crust and uppermost mantle.

The obtained model at the present stage has the following features.

(1) The uppermost part crust consists of 4 layers of Vp= 1.6-2.0, 1.8-3.5, 3.7-5.0 and 4.5-5.5 km/s, representing sedimentary and volcaniclastic rocks. Their geometry shows significant change along the profile line, well correlated with fault and caldera systems developed in the surveyed region under successive tectonic processes in the NE Japan arc.
(2) The velocity of the crystalline upper crust is 5.8-6.1 km/s, but show higher values of 6.0-6.25 km/s in the eastern end of the profile (in the Kitakami Mts.), well consistent with the previous refraction wide-angle reflection studies (Iwasaki et al., 1994, 2001).
(3) The thickness of the middle crust is 5-7 km with a velocity of 6.4-6.5 km/s. The lower crust is composed of three layers with velocities ranging from 6.6 to 7.1 km/s. This part is generally reflective with less seismic activity.

(4) The Moho is situated at 30.5-32 km depth. The Pn velocity is about 7.7 km/s. At the bottom of the lowermost crust, there may exist a 2-km thick transition zone (7.1-7.4~7.5 km/s). Hence, the resultant velocity contrast at the Moho is only 0.2~0.3 km/s.
(5) The uppermost part of the mantle is also reflective, which contains two velocity discontinuities with a contrast of 0.1~0.2 km/s at depths of 38 and 46 km.
(6) Low frequency earthquakes are occurring at depths of 17-40 km, just within the reflectivity zones in the lower crust and uppermantle found from the present study.
(7) Gross structural features (velocity values and crustal thickness) are well consistent with those from the tomographic analyses by Kurashimo et al. (2021, 2022).

References

Iwasaki et al., 1994. *J. Geophys. Res.*, **99**, 22187-22204.
Iwasaki et al., 2001. *Geophys. Res. Letters.*, **28**, 2329-2332.
Iwasaki et al., 2021a. 2021 JpGU Meeting, SCG49-05.
Iwasaki et al., 2021b. Program and Abstract of the 2021 Fall Meeting of Seismological Society of Japan, S06-03.
Iwasaki et al., 2022. 2022 JpGU Meeting, SCG50-04.
Kurashimo et al., 2021. 2021, JpGU Meeting, SCG49-04.
Kurashimo et al., 2022. 2022, JpGU Meeting, SCG50-03.
Sato et al., 2020a. 2020 JpGU-AGU Joint Meeting, MIS03-P05.
Sato et al., 2020b. 2020 Spring Meeting of JAPT, 016.

