Three-dimensional S-wave attenuation structure in and around Hokkaido, Japan

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1. Introduction

At Hokkaido, Japan, the collision between the Kuril and the NE Japan arcs occur (e.g., Kimura, 1994, JGR), and thus complicated crustal structure would be developed. According to Kita et al. (2012), the arc-crust is subducted by the collision and reaches deep up to near the upper part of the mantle. Additionally, the 2018 Eastern Iburi Earthquake (M6.7, depth 37 km) and its aftershocks occurred at considerably deep as a crustal earthquake. This activity at the deep crust is thought to link to the complicated geologic structure in Hokkaido.

Several detailed tomographic studies of seismic velocity and Qp structures have been done in this region (e.g., Kita et al., 2014, JGR; Shiina et al., 2018, JGR). These studies showed low Qp, low Vp, low Vs, and high Vp/Vs at a depth of 10 km in the west side of the Hidaka mountain range and that these anomalous structures distribute to the depth of 50 km which comparable to the upper surface of the subducting Pacific plate. On the other hand, the Qs structure in this area has not been well investigated. Therefore, in this study, we estimate the detailed Qs structure of Hokkaido by using the 3D spectrum inversion method.

2. Method and Data

In this study, we adopt the 3D spectral inversion method (Nakamura and Uetake, 2002) to strong motion records observed around the Hokkaido. In the method, we estimate source spectrums, site factors, and Qs value of each block. The study area is 138 ˚- 148 ˚E and 39 ˚- 46 ˚N, and is discretized by blocks of which size is 0.1 ˚in latitude and longitude and 10 km in depth direction.

The strong motion records are collected from on the K-net and the KiK-net stations deployed near the surface. Periods collecting the records are to Nov. 2019 from operation beginnings of each station. The magnitude of earthquakes is 4.0 - 7.5. We limit stations by epicentral distances: < 100 km and < 500 km for earthquakes occurred at depths of 0-30 km and 30-200 km, respectively. Moreover, we exclude strong motion records with 100 Gal or stronger to reduce influences of ground nonlinearity effects as possible. Fourier spectrum amplitudes are computed from the strong motion records of NS component at 1-10 Hz with every 1 Hz.

3. Results

We show the estimated Qs structure in and around the Hokkaido obtained at 10 Hz in Figure 1. In this study, we examine the CKB resolution test and, in Figure 1, we display only the results where the assumed structures are well recovered in the resolution test. The obtained Qs structure reveal the high-attenuation (low-Qs) zones beneath the volcanoes at depths of 30-40 km and the Pacific slab with low-attenuation (high-Qs), as well as tomographic images in Tohoku district (e.g., Nakamura and Uetake, 2004; Liu et al., 2014).

At the west side of the Hidaka mountain range, the remarkable high-attenuation zone is estimated at depths of 0-20 km and there seem to continuously distribute by about 40 km. This high-attenuation anomaly is consistent with that estimated in Qp (Kita et al., 2014). Additionally, the belt-like distribution of low-attenuation area along the Hidaka mountain range can be revealed in this study. These structures would represent heterogeneity resulted from the collision between Kuril and NE Japan arcs.
Around the source area of the 2018 Hokkaido Eastern Iburi Earthquake, high S-wave attenuation is imaged. The high-attenuation zone is extended from near the Hidaka mountain range (the result at 30-40 km in Figure 1) and the contrast of between high- and low-attenuation property clearly identified along the north-south direction. This is comparable to distributions of aftershocks of the Eastern Iburi earthquake. Therefore, we consider that the heterogeneous structures which are developed in the collision zone would closely link to the occurrence of the Eastern Iburi earthquake and its aftershocks.

Keywords: Hokkaido, Collision zone, S wave attenuation structure, the 2018 Eastern Iburi Earthquake

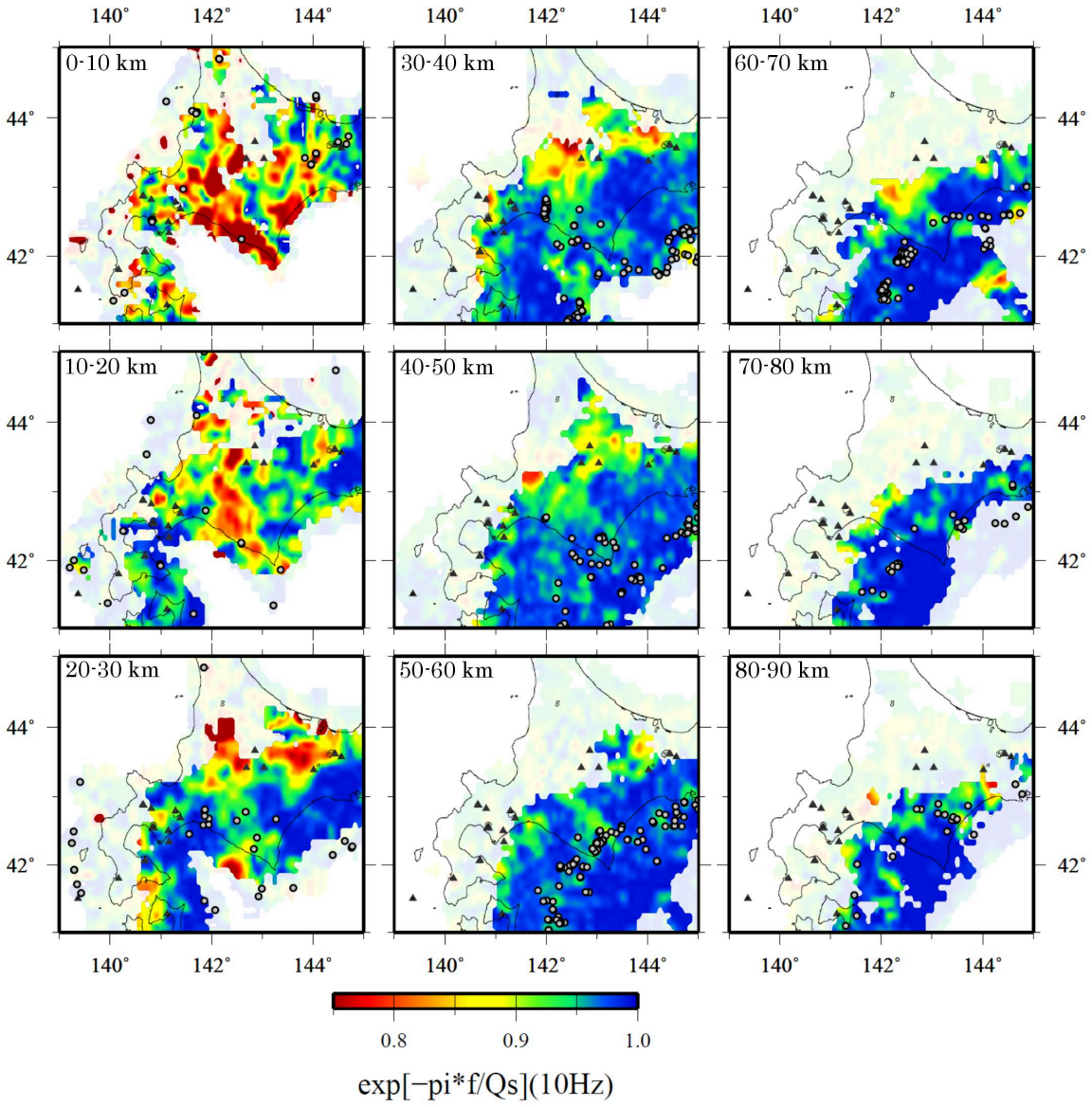

Fig.1 Qs structure in and around the Hokkaido, Japan, obtained at 10 Hz. Less resolved area are masked in the figure. White circles denote the locations of earthquakes used in this study. Black triangles is active volcanoes.

