

Estimate of structure of the Philippine Sea slab and the surrounding region beneath southern Kyushu, southwestern Japan with seismological techniques

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1. Introduction

In order to contribute to the investigations of the generation processes of Hyuganada earthquakes and the eruption processes of Sakurajima and Kirishima volcanoes, we try to estimate the seismic structure of the Philippine Sea slab and the surrounding region beneath southern Kyushu, southwestern Japan with receiver function analysis and seismic tomography.

2. Receiver function analysis

We carried out linear array seismic observations along Miyazaki–Akune and Miyazaki–Sakurajima profile lines. We deployed temporarily short-period seismometers along the two profile lines with an average spacing of ~5 km. We applied receiver function analysis and obtained images of S wave velocity discontinuities.

We can see seismic velocity discontinuities such as the continental Moho and the oceanic Moho in the receiver function images. The continental Moho is clear in the middle–west part of the profile lines, however it becomes unclear near the mantle wedge. This suggests that the seismic velocity is low in the mantle wedge due to the fluids discharged from the oceanic crust. The oceanic Moho in the Philippine Sea slab is clear up to the depths of 80–100 km and it bends convex upward at ~60 km. This can be explained by eclogitization of the dehydrated oceanic crust.

We can also find that low frequency event areas beneath Kirishima and Sakurajima volcanoes have very low seismic velocity from the receiver function images. This suggests the existence of fluids that would be related to the volcanic activities.

3. Seismic tomography

We used the temporary stations in the linear arrays mentioned above as well as permanent and temporary seismic stations deployed in the southern Kyushu region. We selected 1566 events for the tomography. The grid size of the seismic velocity model is $0.1^\circ \times 0.1^\circ \times 10$ km. The initial velocity values are given by the JMA2001 model (Ueno et al., 2002). Our model has three velocity discontinuities, the continental Moho, the slab top and the oceanic Moho. The geometries of the discontinuities are determined by

referring to a continental Moho model by Katsumata (2010) and a Philippine Sea slab model by Iwasaki et al. (2015).

Map views of the heterogeneous P wave velocity at every 10 km depths show the following features: low velocity anomalies are located in the vicinity of Kirishima, Sakurajima and Kaimondake volcanoes at 10 km depth. Strong low velocity anomalies are distributed widely in the surrounding region of the three volcanoes and near the coastal region of the Hyuga-nada Sea at 20 km depth. The oceanic crust shows low velocity anomaly at 30 and 40 km depths, however it turns high velocity anomaly at 50 and 60 km depths.

Fig. 1 shows E-W cross-sections of the heterogeneous P wave velocity passing through the Kirishima, Sakurajima and Kaimondake volcanoes. Strong low velocity anomalies are distributed widely in the crust beneath the volcanoes and in the sea-side area from the tip of the mantle wedge. The oceanic crust turns high velocity anomaly at 50–60 km depths, however it becomes low velocity anomaly again at the deeper parts. The island arc side mantle shows widely low velocity anomaly.

These low velocity anomalies can be caused by the slab derived fluids and the resulting magma. The dehydration of the oceanic crust could be occurred in the low velocity anomalies near the tip of the mantle wedge and those located deeper than 80 km.

We used seismic data from permanent stations of NIED, JMA, Kyushu Univ. and Kagoshima Univ. and temporary stations of Univ. of Tokyo. This work was supported by JSPS KAKENHI 16K05540.

Keywords: Seismological structure, Philippine Sea slab, Southern Kyushu, Receiver function analyses, Seismic tomography

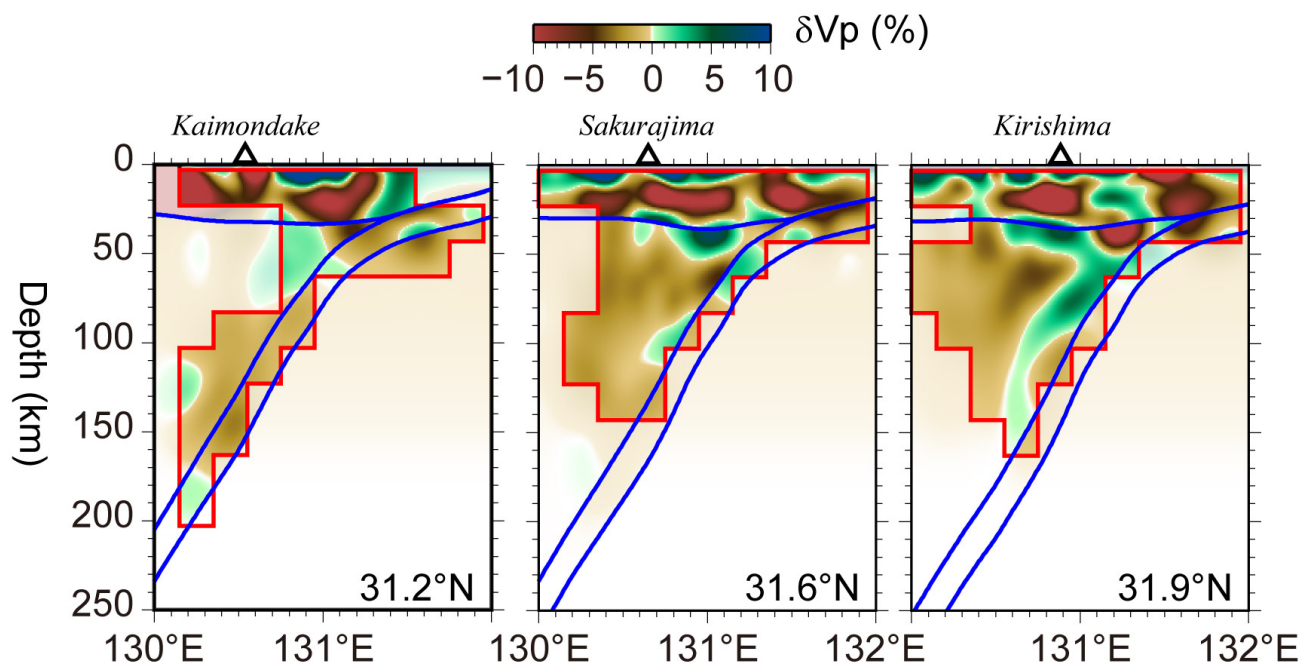


Fig.1 E-W cross-sections of the heterogeneous P wave velocity passing through the Kaimondake, Sakurajima and Kirishima volcanoes. The perturbation from JMA2001 velocity model are shown. The checker board test shows good recoveries in the thick red line. The thick blue lines shows the continental Moho, the slab top and the oceanic Moho.