Letter

Bull. Volcanol. Soc. Japan
Vol. 57 (2012) No. 4, pp. 227−234

Seismic Velocity Structure of the Crust Beneath the Aira Caldera in Southern Kyushu by Tomography of Travel Times of Local Earthquake Data

Paul Karson ALANIS*†, Hiroki MIYAMACHI*, Hiroshi YAKIWARA*, Kazuhiko GOTO*, Reiji KOBAYASHI*, Takeshi TAMEGURI** and Masato IGUCHI**

(Received October 1, 2012; Accepted December 7, 2012)

We applied the tomography method to the P- and S-wave arrival times of 829 local earthquakes observed at 101 stations in central and southern Kyushu, and revealed the detailed three-dimensional seismic velocity structure of the crust, especially the region beneath the Aira caldera. The structure obtained beneath the Aira caldera was characterized by a compacted high Poisson's ratio zone at about 20 km depth, suggesting fluid saturation such as partial melts relating to volcanism. We also found that the low frequency earthquakes occurred so as to infill the lower crust between the high Poisson's ratio zone and the moho discontinuity beneath the Aira caldera. It was also obvious that earthquakes clearly concentrated in regions with low Vp/Vs (low Poisson's ratio) in the upper crust of the whole of southern Kyushu.

Key words: Aira caldera, Sakurajima, velocity structure

1. Introduction

Southern Kyushu (Fig. 1) is bordered by the N40° E trending Nankai Trough where the Philippine Sea (PHS) plate subducts to a direction of N50° W beneath the Eurasian plate at the rate of 4−5 cm/yr (Seno *et al.*, 1993). Associated with this subduction a nearly straight chain of active Quaternary volcanism runs almost parallel to the trough in the central part of the island. In southern Kyushu, there are four large calderas: the Kakuto, the Aira, the Ata and the Kikai calderas. Large-scale pyroclastic eruptions about 29,000 years before present in the calibrated age led to the formation of the Aira caldera (Aramaki, 1984; Okuno, 2002). Especially, Sakurajima volcano in the Aira caldera has been very active.

Using a seismic velocity inversion technique, Sadeghi *et al.* (2000) obtained a three-dimensional (3-D) seismic structure of east China and western Japan and found high velocity zones (HVZs) existed beneath Kyushu due to the subducting PHS plate, whereas low velocity zones (LVZs) existed in western Kyushu, which they cited as evidence of mantle upwelling and back-arc spreading. Yakiwara (2000) reported low P- and S-wave velocity zones beneath Unzen, Aso, Kirishima and Sakurajima volcanoes and suggested the presence of partial melts. Meanwhile, Salah and Seno (2008), Tahara *et al.* (2008), Wang and Zhao (2006) and Xia *et al.* (2008) modeled the mantle wedge beneath Kyushu as low Poisson's ratio zones and concluded them to be due to fluid saturation from the dehydration of the subducting PHS plate. Wang and Zhao (2006) also indicated widespread low velocity zones beneath volcanoes in Kyushu. All these previous studies pointed out that the low velocity zones revealed by their 3-D tomography were closely related to volcanism in Kyushu.

In this study we focused on obtaining a detailed 3-D seismic velocity structure up to 50 km depth underneath southern Kyushu, specifically the Aira caldera, by tomography of arrival times from local earthquake data with finer grid configuration than that in the previous tomography studies. The obtained velocity structure should reveal the velocity variation related to the volcanic and seismic activity in southern Kyushu.

2. Data and Methodology

In order to reveal the crustal structure in and around the Aira caldera in southern Kyushu, we set up a wide study area with a range of 30° N−32.25° N and 129.25° E−132.

* Graduate School of Science and Engineering, Kagoshima University, Korimoto 1−21−35, Kagoshima 890−0065, Japan.
** Sakurajima Volcano Research Center of DPRI, Kyoto University, Sakurajima-Yokoyama, Kagoshima 891−1419, Japan.
† present address : Philippine Institute of Volcanology and Seismology, Philippines

Corresponding author: Hiroki Miyamachi
e-mail: miya@sci.kagoshima-u.ac.jp