Tomographic imaging of the 2016 Kumamoto earthquake area

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On 16 April 2016, the Kumamoto earthquake (M7.3) occurred due to the rupture of the Futagawa-Hinagu fault zone in Kyushu. Its big foreshocks took place at 21:26 on 14 April 2016 and 00:03 on 15 April (M6.5 and M6.4, respectively), and more than 4000 aftershocks with a seismic intensity greater than 1 have occurred by 31 December 2016. The Beppu-Shimabara rift zone and the Beppu-Haneyama fault zone in Ooita Prefecture have been activated, where several active arc volcanoes exist, such as Aso, Kuju, and Tsurumi-dake. Hence, the influences of the 2016 Kumamoto earthquake on volcanic activities are concerned. To clarify the generating mechanism of the Kumamoto earthquake, we applied seismic tomography methods to study the 3-D velocity structure of the crust and upper mantle beneath the Beppu-Shimabara rift zone.

Our study region is in the range of 30.5N ~ 34.5N and 129.0E ~ 133.0E in Kyushu. We inverted a large number of high-quality arrival-time data of P and S waves using the isotropic tomography method of *Zhao et al*. (1992, 2011) and P-wave anisotropic tomography method of *Wang and Zhao* (2013). The lateral grid interval is ~20 km for the isotropic tomography and ~40 km for the anisotropic tomography. In the crust and mantle wedge, grid nodes are set up at depths of 1, 10, 25, 40, 60, 80, 100, 120, 140, 160, 180 and 200 km. In the subducting Philippine Sea (PHS) slab which is assumed to be 4% faster than the surrounding mantle, grid nodes are set up at depths of 5, 15 and 30 km below the slab upper boundary. We used 195 seismic stations, and the arrival-time data are selected from the Japan Unified Earthquake Catalogue and the seismic database of Tohoku University.

Main results of this work are summarized as follows.
(1) In the mantle wedge under the Kyushu forearc, our tomographic results revealed predominant low-velocity (low-V) zones, which reflect forearc mantle serpentinization due to abundant fluids from the dehydration of the PHS slab (e.g., *Abe et al*., 2013). Our anisotropic tomography shows that the fast-velocity direction (FVD) is trench-parallel under the forearc area.
(2) In the mantle wedge beneath the volcanic front and the back-arc area, significant low-V zones are revealed, and the FVD is found to be trench-normal, which reflect arc magmatism caused by a combination of the PHS slab dehydration and corner flow in the mantle wedge (e.g., *Zhao et al*., 2011; *Wang and Zhao*, 2013).
(3) In the Beppu-Shimabara rift zone, the big foreshocks and the main shocks are located in a high-velocity zone in the upper crust. However, significant anomalies of low-V and high Poisson’ s ratio are imaged in the lower crust and the uppermost mantle beneath the source zone. These results suggest that fluids from the PHS slab dehydration ascend through the mantle wedge to the upper crust, which infiltrated the Futagawa-Hinagu fault zone and triggered the 2016 Kumamoto earthquake *(Zhao and Liu*, 2016).

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