Three-dimensional structure of Vp and Vs in the central part of Japan and its implications for return flow and arc magmatism

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The Pacific plate subducts beneath eastern Japan on the North American (or Ohotsuku) plate at the Japan and Kurile trenches and produces a long volcanic chain from Hokkaido to Tohoku without large gaps. Our recent studies through seismic tomography have revealed the distinct inclined low-velocity zone in the mantle wedge beneath Tohoku and Hokkaido, northeastern Japan, sub-parallel to the down-dip direction of the Pacific slab (Nakajima et al., 2001; Nakajima and Hasegawa, 2005). The zone is considered to be the upwelling flow induced by the viscous coupling between the subducting and overriding plates (Hasegawa and Nakajima, 2004). The location of the volcanic front agrees well in space with regions where the upwelling flow reaches the Moho and, therefore, we infer that the upwelling flow is the main source of arc magmas and plays a crucial role in forming arc volcanoes.

The volcanic chain beneath the central part of Japan, where the Philippine Sea plate subducts to the north between the Pacific and the overriding continental plates, shows a different feature and deflects toward the back-arc side. A numerical simulation (Iwamori, 2000) showed that the shift of the volcanic chain to the west is due to the anomalous thermal structure resulting from the subduction of the Philippine Sea plate.

We conducted a seismic tomography beneath the central part of Japan to reveal the heterogeneous structure in the mantle wedge. Obtained results show the presence of the prominent low-velocity zone inclined in the mantle wedge even beneath the central part of Japan. The low-velocity zone shifts gradually to the west corresponding to the shift of the volcanic chain, which again indicates that the upwelling flow controls the location of arc volcanoes.