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Seismological constraints on the upwelling flow in the mantle wedge of Hokkaido and Tohoku, Japan, and its role on arc magmatism

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Seismic tomography studies have revealed an inclined low-velocity zone in the mantle wedge of Tohoku and Hokkaido, Japan, which is distributed sub-parallel to the down-dip direction of the slab at depths shallower than ~150 km [1,2]. The zone is considered to be an upwelling flow portion of the secondary convection mechanically induced by slab subduction [3,4]. Shear-wave polarization anisotropy analyses conducted for Tohoku and Hokkaido have provided a new insight into the flow pattern [5,6], in which the upwelling flow appears to be generated sub-parallel to the maximum dip-direction of the subducting slab, not to the relative plate motion. In Tohoku, seismological observations have revealed further characteristic features. A quantitative analysis of the inclined low-velocity zone shows that the upwelling flow contains melt inclusions with volume fractions of 0.1-3 % [7], suggesting that the upwelling flow is the main source of arc magmas. Interestingly, the inclined low-velocity zone (upwelling flow) shows an along-arc variation in its S-wave velocity reduction rate: very low velocity regions periodically occur about every 80 km along the strike of the arc. Clustering of Quaternary volcanoes and topographic highs at the surface are located immediately above very low-velocity areas in the mantle wedge, and low-frequency microearthquakes, perhaps caused by rapid movements of fluids in the lower crust, also occur right above them [4]. These observations suggest that the upwelling flow plays an important role on arc magmatism and the 3D magma supply system is working beneath Tohoku.

Keywords: Tohoku; Hokkaido; mantle wedge; low-velocity zone; upwelling flow; melts; arc magmatism

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