Thermal structure of the Honshu arc deduced from high P-T ultrasonic experiments and seismic tomography

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Quantifying the thermal structure of the overlying plate is essential for understanding the nature of deformation of the island arc. In order to interpret seismic tomography into thermal structure, it is important to accurately measure the temperature dependence of elastic wave velocity of lower crustal/upper mantle rocks and minerals. In this study, simultaneous measurements of ultrasonic compressional wave velocities (Vp), shear wave velocities (Vs), Vp/Vs ratio and their temperature dependence were conducted on natural xenolith samples collected from the Honshu arc and sintered polycrystalline mineral samples at high temperature and high pressure conditions representative of the lower crust and uppermost mantle of the island arc. The experimental results for each sample have shown a distinct negative temperature dependence of P and S wave velocities. The Vp/Vs ratio, on the other hand, depends heavily on mineral compositions of rocks, not temperature. By extracting regions that are presumed to have the same lithology from the Vp/Vs tomography, Vp perturbations or Vs perturbations of the extracted regions can be interpreted as thermal perturbations. In this study, Vp or Vs in an arbitrary Vp/Vs range were extracted using the three-dimensional seismic tomography of Matsubara et al. (2019), and the thermal structure was estimated from the extracted velocity structure by comparing experimentally determined temperature dependence of Vp or Vs of the samples with Vp perturbations or Vs perturbations in the lower crust and uppermost mantle. An example of the estimated thermal feature is described below. To clarify the temperature perturbation of the lower crust of the NE Honshu arc in the east-west direction, P-wave velocities and S-wave velocities in the range of Vp/Vs = 1.75 to 1.77 were extracted from the seismic tomography of 20km depth. At latitude of 39.75-40˚N, the lower crust of the Ou Backbone Range is estimated to be the hottest, because the extracted velocities of the P and S waves indicate the lowest velocities below the Ou Backbone Range. P-wave velocity and S-wave velocity increase toward Kitakami Lowland (141 ˚E) and Hachirogata (140 ˚E), and the feature suggest that the temperature of the lower crust decreases from the Ou Backbone Range to the east and west sides. The feature is common in the NE Honshu arc, but there are some differences and exceptions in the north-south direction. The detailed thermal structures and estimated temperatures will be discussed in our presentation.

Keywords: seismic velocity, thermal structure, crustal structure

