3D Time Dependent Thermal Model of NE Tohoku Subduction Zone: Possible Role of Dehydrated Water on the Slab-Mantle Interaction

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Water dehydrated from the subducting slab may play important roles in controlling the thermal structure of mantle wedge. The water may lower the solidus, thus, promote the melting and it may also lower the viscosity of the mantle wedge. In this presentation, we focus on the possible role of weakened mantle wedge, which may produce the small-scale convection within the mantle wedge, by comparing the results of numerical simulation with the geophysical and geologic data observed in the NE Honshu subduction zone. Tomographic results constrain the present status of thermal structure by assuming that the temperature anomalies correlate with the seismic anomalies. This comparison constrains the geometry of the low viscosity wedge (LVW) overlying the slab. Then, the time-dependent characteristic of the 3D model with preferred geometry of LVW is studied. Main results are ; (A) 3D calculations of our final model show fairly continuous and strong temperature anomalies (several hundreds degrees) under the volcanic front and weak finger-like temperature anomalies (several tens degrees) behind them, which are similar to the pattern of the seismic tomography. (B) This model has step-like low velocity anomalies above the subducting slab rather than smooth anomalies subparallel to the subducting slab. (C) A movement of cold plumes generated at the back-arc end of the LVW may be related to a possible migration of volcanism from back-arc to volcanic front side as indicated by the observations. To explain the observation, suggesting a speed of migration rate ~ 2 cm/yr, weak couplings between the mantle wedge and the underlying subducting slab, whose speed of subduction is ~ 10 cm/yr. (D) The time-dependent behavior of the temperature field shows that the pattern of fingers flip-flops with a time-scale equal to the ratio of the horizontal extent of the LVW to the migration speed of cold plumes. This change of pattern of fingers may explain the past spatial distribution of volcanoes.