Nature of Seismic Heterogeneity in the Upper Mantle

Azusa Shito[1]; Takuo Shibutani[2]

[1] DPRI, Kyoto Univ.; [2] RCEP, DPRI, Kyoto Univ.

The origin of the seismic heterogeneity (velocity and attenuation) in Earth's mantle is one of the most important issues in the Earth science. Conventionally, in discussions of velocity tomography results, low velocity zones are interpreted as hot regions and high velocity zones are interpreted as cold regions, assuming thermal origins of velocity heterogeneities. However, such interpretations may be inadequate for quantitative arguments and are not always appropriate even qualitatively. To explain lateral variations in seismic wave attenuation and velocities, the importance of water content, chemical composition, and partial melting has been suggested in recent studies. The contribution of each effect on the seismic heterogeneity should be estimated quantitatively to understand dynamics of mantle convection.

We developed the method to separate temperature and water content effect on seismic heterogeneity using attenuation and velocity structures of P-wave. We applied the method to the upper mantle the beneath the northern part of the Philippine Sea region. Observed attenuation and velocity anomalies were evaluated to explain the temperature, water content, and chemical heterogeneities. The results indicate that the observations in the middle part of the upper mantle (300-400 km) can be explained by only the effects of high water content. In contrast, the observed anomalies in the shallower regions (50-200 km) may be due to chemical composition effects, in addition to the temperature and water content anomalies. These inferred properties of the upper mantle are consistent with the tectonic history of the Philippine Sea region, which has had a long history of subduction and active magmatism.