The H2O content of magma generated above 410 km seismic discontinuity

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Seismological observations have revealed the existence of low velocity and high attenuation zones just above the 410 km seismic discontinuity in the Earth's mantle (e.g. Revenaugh and Sipkin, 1994). It has been suggested that the existence of a small amount of melt could be responsible for such anomalies. The density of silicate melt under dry conditions has been measured under high pressure and found to be denser than the surrounding mantle, thereby allowing the melt to exist at this depth. However unless water exists, it is impossible to melt the mantle in the average temperature of ˜1673K at 410 km. Matsukaga et al. (2005) and Sakamaki et al. (2006) examined the density of hydrous magma, and for example, Sakamaki et al. (2006) showed that the water content of magma has to be less than 6.7+-0.6 wt% for the gravitational stability at the pressure and temperature of the bottom of the Earth's upper mantle. Nevertheless, the water content in magma should define as hydrous liquidus line in the silicate-H2O system, and the water content in magma generated in a P-T condition must be unique. Therefore we have determined the water content in the hydrous melt generated at the bottom of the Earth's upper mantle in various temperatures.

Two starting materials, pyrolite-2.9 wt% and 8.3 wt% H2O, were used. High pressure and temperature experiments were carried out using an MA-8 type (Kawai-type) apparatus at pressure of 12.0 GPa and temperatures from 1373K to 1973K. Identification and chemical analysis of the recovered sample was made by SEM-EDS and Micro-Raman spectroscopy. The amounts of melt (degree of melting) were determined from 1) the cross sections of the recovered samples, and 2) the mass balance calculation from the chemical compositions of the recovered samples. Using the result of the degree of melting, the water contents of magma were calculated.

We found that the water content of magma was more than 10 wt% H2O at 1673˜1773K by both image observations and mass-balance calculations. As a result, the water content of magma was ˜18 wt% at 1673K. Therefore, it may be difficult that such hydrous melt is gravitationally stable just above the 410 km seismic discontinuity.