Measurement of thermal properties of slab materials under high pressure

Masahiro Osako[1]; Akira Yoneda[2]; Eiji Ito[3]

[1] Div.Astro.Geophys.,Natl.Sci.Mus.; [2] ISEI, Okayama Univ.; [3] ISEI

Thermal properties of materials of slabs and its surroundings in the mantle controls dynamics of the mantle and, in particular, of descending slabs. The temperature contrast and the resulting density contrast which will be a major source of driving are due to thermal transport properties, i.e. thermal conductivity or thermal diffusivity. We determined thermal conductivity and thermal diffusivity of major mantle materials, olivine and garnet, and provided thermal conductivity values in the condition of the upper mantle, however, these data are for the materials of the dry mantle. Although these materials occupy considerable fractions in the mantle, minor constituents including hydrous phases are important to study behavior of the descending slabs.

Here we have measured thermal conductivity and thermal diffusivity of serpentine at pressures to 8.4 GPa. The sample used was antigorite with light-greenish color and transparency. We applied a pulse heating method for simultaneous thermal conductivity and thermal diffusivity measurement. The measurements were conducted using a Kawai-type high-pressure apparatus at the Institute for Study of the Earth's Interior, Misasa.

The result shows that serpentine has lower thermal conductivity and thermal diffusivity than dry mantle materials: at 2 GPa the values are about half of those of olivine. Moreover, their pressure derivatives are small to a pressure of 5 GPa compared with olivine, and show almost zero or slightly negative above this pressure. It is pointed out this behavior may be due to amorphization of serpentine under pressure. At 5 GPa serpentine could decompose above 800 K, considering thermal conductivity and thermal diffusivity were unobservable. It is said that serpentine is stable below 900 K at 5 GPa, and unstable just above the room temperature at 8.4 GPa. However at 8.4 GPa thermal conductivity and thermal diffusivity at high temperatures showed similar change. This would suggest that the measurements at 8.4 GPa were done for meta-stable state of serpentine. Decrease of thermal conductivity is smaller than that of thermal diffusivity; this will results in large change in the heat capacity at this temperature range, up to 800 K. Nevertheless, the measurements might be conducted during decomposing of serpentine, and therefore, additional measurements were needed to verify whether these results indicate intrinsic in serpentine of not. In any case, hydrous phases may show unexpected behavior in thermal properties, thermal conductivity or thermal diffusivity and heat capacity. At present, we cannot pursuit measurements above the temperatures at which the sample was probably decomposed. So the measurements passing through such phase boundary are difficult owing to disadvantage arising from deformation of the sample or damage of the sample assembly from dehydration, however, determination of thermal properties tracking P-T conditions of a descending slab are interesting and vital for discussing dynamics of the slab.