Lattice thermal conductivity of lower mantle minerals

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Heat in the Earth's interior is transported dominantly by convection in the mantle and core, and by conduction at thermal boundary layers. The thermal conductivity of the bottom thermal boundary layer of the mantle determines the magnitude of heat flux from the core, and is intimately related to the formation of mantle plumes, the long-term thermal evolution of both mantle and core, and the driving force for generation of the geomagnetic field. Recent technical progress both in the experiment and the theoretical calculation enables us to reveal high-pressure and high-temperature behavior of lattice thermal conductivity of lower mantle minerals, $MgSiO_3$ perovskite (bridgmanite) and MgO periclase (e.g., [1,2]). However, the effect of iron incorporation into these minerals on the lattice thermal conductivity is still under debate.

We measured the lattice thermal conductivities both of $(Mg,Fe)(Al,Si)O_3$ bridgmanite and (Mg,Fe)O ferropericlase at the Earth's lower mantle pressures and 300 K using a pulsed light heating thermoreflectance technique in a diamond anvil cell. We found that iron incorporation into bridgmanite showed minor effect on the thermal conductivity. On the other hand, the obtained conductivity of ferropericlase was considerably lower than that of MgO periclase as shown in previous studies [3,4]. The estimated lattice thermal conductivity of bridgmanite-dominant lowermost mantle is comparable to conventionally assumed value of 10 W/m/K [5]. However, our results imply that local existence of (Mg,Fe)O ferropericlase in the lower mantle may induce strong heterogeneity of lower mantle thermal conductivity.

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