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高圧下の輝石の熱拡散率・熱伝導率と沈み込むスラブの熱的状態
Thermal diffusivity and thermal conductivity of pyroxenes under pressure and the thermal state of subducting slabs

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Pyroxene is an important constituent next to olivine in the upper part of the Earth's mantle. Therefore, its thermal properties are indispensable for investigation of the thermal state of the mantle. Moreover, alike olivine, pyroxene reveals anisotropy in thermal conduction. Magnesium-iron bearing pyroxene has the most significance, however, measurements of thermal diffusivity or thermal conductivity of single crystal pyroxene mineral, such as enstatite, are hard to perform under pressure because obtaining sufficient size of sample is a hurdle. So using polycrystalline sample is the next best thing. We measured thermal diffusivity and thermal conductivity of jadeite as a pyroxene analogue material. In addition, we conducted measurements on omphacite and diopside. Omphacite, mostly composed of a solid solution of jadeite and diopside, is the main component of eclogite, a major rock in deep subduction zone and lowermost crust of thickened continents.

Jadeite sample was a natural aggregate of which source was Itoigawa, central Japan. Omphacite and diopside samples were prepared from fused glass of reagent mixture to sintered polycrystals. The synthesis and sintering were carried out using the Kawai-type apparatus at ISEI. The sample cell was installed in a magnesia pressure medium of 25 mm edge-length. The cell assembly was compressed by anvils with a trancation length of 15mm. The synthetic conditions were 5 GPa, 1100 ^{o}C and 120 minutes for omphacite and 5 GPa, 1200 ^{o}C and 120 for diopside. The recovered samples were confirmed by X-ray diffraction and EPMA analysis, and were seen to have small porosity by SEM observations.

Thermal diffusivity and thermal conductivity were measured simultaneously using the one-dimensional pulse heating method (Osako et al., 2004). This method requires three identical sample disks. Measurements of jadeite were carried out using an 18 mm edge-length MgO octahedral pressure medium up to 10 GPa by anvils with 11 mm truncated edge. The diameter of the jadeite sample was 4.3 mm and the total thickness was 1.05 mm, whereas omphacite and diopside samples had a diameter of 3 mm and a thickness of 0.75 mm. The measurements of these minerals were performed at pressures up to 15 GPa using a 14 mm edge-length MgO octahedral pressure medium and anvils with 8 mm truncated edge.

It is remarkable that omphacite has considerable low thermal conductivity, that is 55-60 % of those of its end members, diopside and jadeite. This value is close to that of garnet. The low thermal conductivity of omphacite may come from disturbed ordering of cations in the structure. Dobson et al. (2010) showed that thermal diffusivity (and hence thermal conductivity) of eclogite was equal to that of olivine, whereas majorite has low thermal conductivity compared with those of surrounding materials (wadsleyite- or ringwoodite-rich assemblages). He suggested that this contrast in thermal conductivities yields deep earthquake activity in the deeper part of subducting slab. Whereas our measurements on thermal conductivity of omphacite (and garnet) could lead to low thermal conductivity or thermal diffusivity of eclogite compared with that of olivine. This would cause the same condition at the eclogite bearing layer in the subduction zone. Moreover, the considerable low thermal conductivity of serpentine (antigorite) would even have such potential in the shallower part (depths$<$150 km) of the subduction zone.

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