論文 / 著書情報
Article / Book Information

題目(和文)	下部マントル構成鉱物の高温高圧力下輸送特性測定から推定されるコア-マントル境界熱流量
Title(English)	Core-mantle boundary heat flow inferred from high-P,T transport property measurements on lower mantle minerals
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	地球惑星科学 系 地球惑星科学 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ 理学 ）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The thermal evolution of the earth is the history of its cooling by releasing massive heat from the surface to the outer space — currently estimated as 46±3 TW — as a consequence of the net heat transportation from the Earth's interior mainly via the mantle cooling, radiogenic heating, and the heat transfer from the core to the mantle across the core-mantle boundary (CMB), with other minor contribution such as tidal heating. The CMB heat flux is given by the product of the thermal conductivity of the lowermost mantle and the temperature gradient at the CMB, hence the knowledge of the lowermost mantle thermal conductivity and the temperature profile at the CMB is a key for better understanding the Earth's thermal evolution. The most abundant mineral in the Earth's lowermost mantle is $MgSiO_3$ bridgmanite and post-perovskite, containing a certain amount of iron and aluminum, and possibly hydrogen, as impurities. This dissertation is focused on the thermal conductivity measurements of lower mantle constituent minerals under high pressure (P) and temperature (T) conditions to estimate that of the Earth's lowermost mantle and the amount of CMB heat flow. The present experimental study consists of the following four experimental developments and investigations: the effect of iron and aluminum incorporation on the thermal conductivity of bridgmanite (Chapters 2, 5) and post-perovskite (Chapter 6); the spin state of iron in the lower mantle bridgmanite (Chapters 3, 4); the development of a new heating technique in a diamond anvil cell (Chapter 7); and the effect of hydration on the electrical conductivity of bridgmanite (Chapter 8).

In Chapter 1, I summarize the current understanding of the Earth's total energy budget, and the heat generation and transportation in its interior. I also review the previous studies on the estimation of the thermal conductivity of lower mantle minerals.

In Chapters 2, 5, and 6, the effect of impurity incorporation on the thermal conductivities of bridgmanite and post-perovskite was investigated by a combination of the pulse-light heating thermoreflectance technique and a diamond-anvil cell as a high-pressure generator. The thermal conductivity of bridgmanite showed minimal reduction due to impurity, while that of post-perovskite decreased by ~50% compared to pure $MgSiO_3$ composition by adding 10 mol.% iron to its crystal.

In Chapters 3 and 4, the spin state of Fe in the Earth's lower mantle bridgmanite was revealed by X-ray diffraction measurements and Mössbauer spectroscopy measurements at high-P, which has been an unsolved issue for decades. Lower mantle bridgmanite was found to contain a certain amount of low-spin iron, which questions the general view and has profound implications for mantle dynamics, and the evolution of the early magma ocean.

A new externally heated diamond anvil cell technique capable of performing a relatively temperature-accurate high-P,T experiments up to 1500 K was developed in Chapter 7. Using this heating technique, the water concentration in the Earth's lower mantle was estimated from high-P,T electrical conductivity measurements on water-bearing bridgmanite. Water abundance in the lower mantle bridgmanite was estimated to be lower than 10 ppm wt. H_2O, implying a significantly dry lower mantle.

In the final chapter, I summarize the results and significance of each chapter. The CMB heat flow and the geotherm are estimated based on the present results and added constraints to the core cooling rate. Our estimation shows a coincident match with the conventionally believed CMB heat flow value. A back transformation of post-perovskite to bridgmanite above the CMB referred to as the "double-crossing model", is not likely to take place at the base of the Earth. A huge lateral CMB heat flux variation was inferred from the present estimation, having profound implications for thermo-physical structures of the core and the mantle.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
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