論文 / 著書情報
Article / Book Information

題目(和文)	高温高圧力下における鉄の電気伝導度と地球中心核の熱進化の推定
Title(English)	Electrical conductivity of iron at high P-T condition and its implication for thermal evolution of the Earth ' s core
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学位種別(和文)	博士論文
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 コース	申請学位（専攻分野）： Academic Degree Requested	博士 （理学） Doctor of （Science）
学生氏名： Student's Name	末廣 翔	指導教員（主）： Academic Supervisor(main)	太田 健二
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The core existing at the center of the Earth consists of solid and liquid iron alloy at its inner and outer parts. The Earth's magnetic field protects us from high-energy cosmic ray and solar wind, which is generated by the dynamo action powered by the convection of the liquid outer core. The convection of the outer core is currently dominated both by thermal convection due to heat flow along vertical direction and compositional convection due to release of light element along with crystallization of the inner core. Such dynamics and thermal evolution of the core are mainly controled by the electrical and thermal conductivities of the core. Therefore, knowledge of such transport properies of the core is of great importance to understand not only for the core but also for the mantle and the crust. I have performed some high-pressure experiments to better constrain the conductivity of the terrestrial planetary core. The thesis entitled “Electrical conductivity of iron at high P-T condition and its implication for thermal evolution of the Earth’s core” consists of five chapters.

Chapter 1, "General introduction" provides an overview of the formation and thermal evolution of the Earth core and reviews previous paleomagnetic, theoretical, and experimental studies on the timing of the inner core nucleation. Then, the chapter describes the purpose and the overall structure of the thesis. The early Earth was much hotter than it is today, and all of the metal cores are believed to have melted, with core convection providing a source of geomagnetism for several 1 billion years. Paleomagnetic observations indicate that the intensity of the geomagnetic field fluctuates greatly in a particular age. Although the activation of core convection due to the birth of the inner core has been proposed as the cause, the age of the inner core is not strongly restricted. There is a method to estimate the timing of the crystallization of the inner core by measuring the electrical and thermal conductivity characteristics of the iron alloy that constitutes the Earth's core through high pressure experiments and carrying out model calculations. However, the influence of impurities in the core on the conductivity of iron and the change in conductivity before and after melting of the iron alloy were not sufficiently restricted by the experiment. The purpose of this thesis is to solve these problems by developing a high temperature and high pressure experiment method using a diamond anvil cell (DAC), and to give a strong restriction on the birth time of the Earth’s inner core.

Chapter 2, "The influence of sulfur on the electrical resistivity of hcp iron: implications for the core conductivity of Mars and Earth" restricted the influence of sulfur content on the electrical conductivity of iron under high pressure. Although sulfur is traditionally listed as one of the most likely elements in the Earth’s core in addition to iron and nickel, the effect of sulfur on the iron conductivity is completely unknown. In this chapter, the electrical conductivity of the core based on the iron-sulfur alloy was estimated by measuring the electrical conductivity of the iron-silicon-sulfur alloy up to 110 GPa. The effect of sulfur on the electrical conductivity of iron was found to be relatively small among other core light elements.

In Chapter 3, " High-temperature electrical resistivity measurements of hcp iron to Mbar pressure in an internally resistive heated diamond anvil cell", an internally resistive heated DAC, which is expected to improve spatial homogeneity and temporal stability of generated temperature, was developed with the aim of improving the precision of high-temperature and high-pressure electrical conductivity measurement. This technique enables the measurement of electrical conductivity with smaller temperature uncertainty, and it is proposed to be a useful technique for materials with relatively low conductivity such as iron alloys.

In Chapter 4, "Electrical resistance of liquid iron up to 70 GPa" A new method of sealing an iron sample in a DAC has been designed to make it possible to measure the electrical conductivity while suppressing the change of the sample shape due to melting. As a result, we succeeded in measuring the conductivity of molten iron under much higher pressures than that of previous research, and it became possible to quantitatively discuss the change in the conductivity of molten iron under the earth core condition.

In Chapter 5 "synthesis", we estimated the electrical and thermal conductivities of sulfur containing molten iron alloys at the Earth’s outer core conditions based on the experimental data obtained in this thesis. The decrease in electrical and thermal conductivity of pure iron due to sulfur content and melting was quantitatively evaluated, and the thermal flow rate of the core was calculated from the thermal conductivity of. The results support a young inner-core age of about 800 million years and are consistent with the period of increasing geomagnetic intensity seen in recent paleomagnetic studies. At the end of this thesis, the unsolved problems and future works for determining the thermal conductivity, heat flow of the Earth’s outer core, and the inner core age were summarized.

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。
Note：Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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