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ITS STRUCTURE AND DYNAMICS

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PREFACE

The study of the Earth's deep interior covers an important area of the current Earth science. Corresponding to the international activities led by the committee in the International Union of Geodesy and Geophysics on "the Study of the Earth's Deep Interior (SEDI)," we initiated a three year program, "the Earth's Central Core," in 1990, with a financial support from Ministry of Education, Science and Culture (Grant-in-Aid for Scientific Research). This volume contains the latest papers associated with the program.

In contrast to the near-surface portions of the Earth, of which we have become to hold a comprehensive perspective in the frame-work of plate tectonics, our understanding is rather limited with the central part of the Earth. During the past several years, remarkable progress has been made also in this area. Among the achievements attained in our program, are the high pressure experiments that doubled the maximum pressure to 50 GPa by use of sintered diamond anvils. A high density network of seismic stations, called J-array, was also formed over the Japan Island arc spanning 20 degree of arc to examine seismic waves that passed through the deep mantle and the core. A super-conducting gravimeter began its measurement in the Antarctic to detect core undertones. Numerical simulations of the geodynamo have been conducted extensively. However, the situation is still far from satisfactory. There are many things left unsolved with the structure, dynamics and energetics of the Earth's deep interior. Even with the issues that are believed to have been once solved, there is often room for re-examination.

Temperature distribution, for example, of the core and the lower mantle is still underdetermined with a wide range of uncertainty. To narrow the range, precise experiments to determine the melting points of iron and iron alloys at core pressures are necessary.

Another factor that has a great influence on temperature is distribution of heat sources. There were hot arguments about the existence of potassium in the core, because potassium is the only siderophile element among the main radiogenic substances of the Earth, and therefore the only candidate for the radiogenic heat source in the core. In fact, high pressure experiments suggest that potassium can coexist with iron at the core pressures. Nevertheless many people now incline to believe that the possibility of existence of potassium is small, since potassium is so volatile an element that might be possibly lost into space at the early stage of the Earth's history. However, any decisive evidence against its existence has not yet presented.

Compositional convection is now widely accepted as the most predominant driving mechanism of fluid motions in the core, and as the most potent energy source for the geodynamo. The inner core grows, solidifying almost pure iron, and supposedly leaving liquid rich in light elements at the surface of the inner core. The liquid thus separated is less dense than the original outer core liquid, and therefore driven to rise. How briskly this type of convection occurs depends on the density difference between the separated iron alloy liquid and the surrounding liquid of the outer core. However, the density difference is not yet well constrained.

With D" layer, too, we have many things to solve, such as its thickness, topography of the core mantle boundary, and the relation to the thermal and the chemical boundary layer at the bottom of the mantle. Besides these, there exist diverse problems that are inter-related to each other.

I wish that this volume might contribute to disentangle the intricate problems and to construct a grand view of the Earth's deep interior. I would appreciate the support (Grant-in-Aid for Publication of Scientific Research Result) from the Ministry of Education, Science and Culture for publishing this monograph. Finally I record my sincere thanks to Dr. Yoshimori Honkura for his assistance and devotion to editing this volume, without which the book would not be in the present form.

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