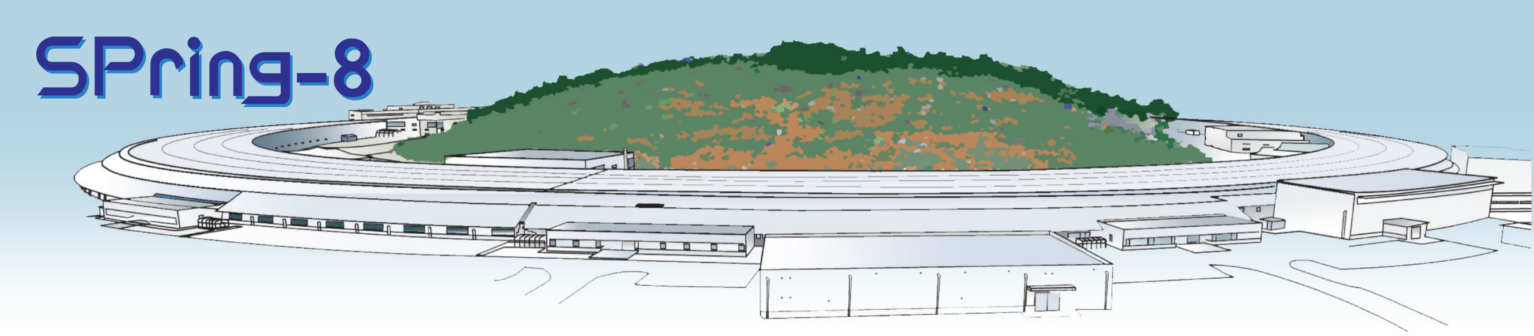


# Elucidation of Material of Earth's Core

Kei Hirose, Professor, and Shigehiko Tateno, specially appointed Assistant Professor, of Tokyo Institute of Technology, and Yoshiyuki Tatsumi, Program Director, of the Japan Agency of Marine-Earth Science and Technology, in collaboration with Yasuo Ohishi, Senior Scientist, of the Japan Synchrotron Radiation Research Institute, have found that the material of the inner core (solid core) at the deepest part of the earth is iron with a hexagonal close-packed structure.

The center of the earth consists of a metallic core with a radius of 3,500 km. The core is divided into an inner solid core (inner core) and an outer liquid core (outer core); that is, the inner core, with a radius of 1,200 km, makes up the deepest part of the earth. On the basis of previous research results, it is widely considered that the inner core consists primarily of iron and approximately 5% of nickel.

The interior of the earth exists under high-pressure and -temperature conditions. The inner core at the center of the earth is considered to be under the ultrahigh pressure of 330 - 364 GPa and the ultrahigh temperature of 5,000 K or higher (the temperature is uncertain and ranges from 5,000 K to 6,000 K). No one had ever succeeded in realizing the conditions of such ultrahigh pressure and temperature in a laboratory until very recently. On the basis of experiments under low pressure and theoretical calculations, various structures such as the hexagonal close-packed structure, body-centered cubic structure, face-centered cubic structure, orthorhombic structure and double hexagonal close-packed structure have been suggested for the crystal structure of iron in the inner core, which has been the cause of considerable controversy.

This research group has developed technologies related to the generation of ultrahigh-pressure and -temperature conditions using a device called a diamond cell (Fig.1). Very recently, they have succeeded in generating ultrahigh-pressure and -temperature conditions similar to those at the center of the earth.

To examine the changes in the crystal structure of metallic iron, they performed experiments under pressures up to 377 GPa and temperatures up to 5,700 K using the high-brilliance X-rays at the High Pressure Research Beamline BL10XU of SPring-8. It was elucidated that a dense structure, the hexagonal close-packed structure, is stable under the ultrahigh-pressure and -temperature conditions in the inner core (Fig.2), and that crystals of iron must be preferentially aligned so that the c-axis is parallel to the earth's axis of rotation to explain the strong seismic anisotropy (significant variations in seismic velocity and rate of attenuation depending on the direction of propagation) observed in the inner core.

Reference: "The Structure of Iron in Earth's Inner Core"; Shigehiko Tateno, Kei Hirose, Yasuo Ohishi, and Yoshiyuki Tatsumi; Science **330** (6002), 359 - 361 (2010)

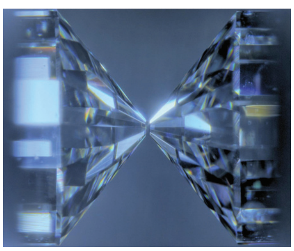

**Fig. 1 Diamond anvil for generating ultrahigh pressure**
The specimen is sandwiched between two diamond anvils and pressurized to 300 GPa or higher.

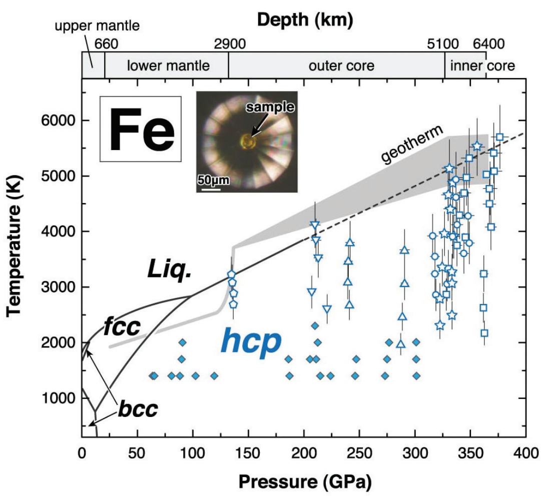


**Fig. 2 Changes in the crystal structure of iron under high pressure and temperature (phase diagram)**
Geotherm: temperature profile of earth's interior
hcp: hexagonal close-packed structure
fcc: face-centered cubic structure
bcc: body-centered cubic structure
Liq.: liquid phase