EARTH & PLANETARY

Synchrotron radiation-based techniques have become an essential tool for fields as wide-ranging as mineral physics, geology, and environmental matters. Advances in synchrotron radiation instruments and techniques and the upgrade of scientific applications have made it possible to measure many physical and chemical properties of deep Earth materials under extreme conditions and those of extraterrestrial matters. In 2010, new research findings came from *in situ* X-ray diffraction and high-resolution synchrotron imaging through cutting-edge techniques and analysis in earth science. Here, we introduce five outstanding topics in the research field of Earth and Planetary Science.

Tateno *et al*. presented the successful result for generating 377 GPa and 5700 K, corresponding to the high-pressure and high-temperature conditions in the center of the Earth, using the laser-heated diamond anvil cell. *In situ* X-ray diffraction observation of materials under such extreme conditions has been one of the absolute goals in the high-pressure research program at SPring-8. They found that solid iron, the main element in the Earth's core, at the center of the Earth has a hexagonal close-packed (hcp) structure and suggested that the Earth's inner core anisotropy in seismic velocities may be caused by the texturing of aggregate hcp iron crystals.

Irifune *et al*. expanded the measurable pressure range at high-temperature in X-ray studies using a combination of a recently developed large-volume press of a multianvil apparatus (MA) with sintered diamond anvils and synchrotron radiation. The feature of uniform P-T conditions with large sample volumes in MA has made it possible to study complex systems and accurate bulk physical properties. Using the new technique, they investigated the detailed phase relations, density change, and element partitioning of a lower mantle material up to 50 GPa and 220 K and indicated that pyrolite, a hypothetical representative bulk composition for the mantle, is a reasonably good model composition for the upper part of the lower mantle.

Science

Nishi *et al*. studied the kinetics of high-pressure back transformation in the Earth's mantle mineral of majoritic garnet, for the purpose of experimentally constraining the ascent speed of diamonds from deep Earth to the surface of the Earth. They carried out time-resolved X-ray diffraction measurements with energy-dispersive method by combining a Kawai-type high-pressure apparatus and synchrotron radiation and revealed that diamonds would be transported by magma with an ascent rate of over 60 km/s.

Uesugi *et al*. studied the texture of extraterrestrial materials of meteorites nondestructively using synchrotron radiation X-ray microcomputed tomography (CT) and applied the X-ray CT data to quantitative analysis of the chemical compositions of individual minerals in meteorites by combining the textural information. By increasing the number of data, the new method using X-ray CT can provide reliable classification of extraterrestrial materials, including meteorites and interplanetary dust.

Asahara *et al*. reported the elastic properties of high-pressure ice VII using Brillouin spectroscopy with simultaneous X-ray diffraction at high pressure. They observed the discontinuity of volume, bulk modulus, and shear modulus at high pressure on the structural phase transition of ice VII to X, suggesting that the hydrogen bonding state is closely related to the elastic properties. Because of the existence of ice within deep Earth as well as icy satellite interiors, the change of elastic properties of ice would have an influence on their structures and dynamics.

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