EARTH & PLANETARY

Advances in synchrotron radiation techniques and current challenges in the study of Earth materials have made the remarkable growth in Earth and planetary science research possible. New beamline techniques and analytical methods, of which developments and upgrades are still continuing, allow us to produce significant new results. Furthermore, recently developed *in situ* simultaneous measurement systems, combining synchrotron radiation techniques with non-synchrotron techniques, have yielded outstanding results, including numerous breakthroughs. In this chapter, we have selected three outstanding and two representative studies published in 2008 among many articles on Earth and planetary science research.

Nakamura and Tsuchiyama studied small particles from the short-period comet 81P/Wild 2 that were obtained by the Stardust mission using micro X-ray diffraction, micro X-ray tomography, and field emission scanning electron microscope. They found that the crystalline particles from the comet were mineralogically, texturally, and compositionally similar to chondrules, suggesting that classical models of the formation of the solar system need major modifications. Irifune and Higo demonstrated the utility of a combination method of X-ray diffraction, radiography, and ultrasonic measurements with a large-volume press apparatus, and studied the sound velocities of minerals in the Earth's mantle transition zone at pressures up to 20 GPa and temperatures up to 1800 K to understand the composition of the mantle transition region. They found that the seismic velocitiy of the pyrolite composition is consistent with typical seismological models in the upper to middle parts of the region, and in the lower part of the region the subducted slab materials are stagnant around the 660 km discontinuity. Hirose *et al*. have, for the first time, observed high electrical

SCIENCE

conductivity of post-perovskite under the conditions of the lowermost mantle of the Earth using an X-ray diffraction and electrical conductivity measurement system with a laser-heated diamond anvil cell. Their results suggested that a post-perovskite layer above the core-mantle boundary markedly affects the rotational vibration of the Earth through strong electromagnetic coupling between the fluid outer core and the solid mantle. Nakajima and colleagues presented an *in situ* high-pressure and high-temperature X-ray diffraction study of iron carbide (Fe_3C) and iron hydride (FeH_x) with a large-volume press apparatus, examining the effects of carbon and hydrogen on the melting temperature of iron at high pressures up to 30 GPa. They obtained detailed melting curves of Fe_3C and FeH_x at high pressures that led them to conclude that the temperature of iron in the outer core is significantly affected by carbon and hydrogen. The last topic is by Lee *et al.*, who examined the local structure change of oxygen in $MgSiO_3$ glass at high pressures by X-ray Raman spectroscopy in a diamond anvil cell. Their results provided important information about transport properties of magma in the Earth's mantle.

Yasuo Ohishi