Migration of Cs-rich microparticles released from the FDNPP in the surface environments

G. FURUKI [1], R. IKEHARA [1], M. SUETAKE [1], A. OCHIAI [1], J. IMOTO [1], S. YAMASAKI [2], K. NANBA [3], T. OHNUKI [4], AND S. UTSUNOMIYA [1]

[1]Department of Chemistry, Kyushu University, Motooka 774, Nishi-ku, Fukuoka 819-0395, Japan
[2]University of Tsukuba, Ibaraki 305-8577 Japan
[3]Fukushima University, Fukushima, 960-1296 Japan
[4]Tokyo Institute of Technology, Tokyo 152-8550, Japan

Nuclear disasters at the Fukushima Daiichi nuclear power plant (FDNPP) resulted in radioactive Cs contamination in the surface environments. Although initial Cs species was considered to be soluble, sparingly soluble Cs-rich microparticle (CsMP) is another form of Cs contaminant in the environments, which has high localized radioactivity; ~10^{11} Bq/g, and is an impotant medium for the transport of fission products and actinides to the environments. We have investigated CsMPs separated from estuary sediments in addition to the other various environments to obtain the evidence of the transport via surface waters and to elucidate the environmental impacts.

Estuary sediments were collected from the Kuma River located ~4.0 km south of the FDNPP, which were transported during floodings. Paddy soils were also collected in the Kuma River catchment. We investigated soils at 3.0 km distant from FDNPP and the atmospheric particles from Tokyo (~230 km distant). After autoradiography and the gamma radioactivity measurement, the CsMP was observed using a scanning transmission electron microscopy.

The fraction of radioactivity derived from CsMPs was estimated to be ~23% of the total Cs radioactivity in the estuary sediment, which is within the range for the soils, 10-40%. No CsMP was detected in 6.45 L of the river water during the static period, 2016, indicating that the floodings caused the migration of CsMPs. The estuary CsMPs are ~1.0 μm in size with the radioactivity per unit mass of (2.22-3.78)×10^{11} Bq/g. The CsMPs comprise Fe-Zn oxide nanoparticles, franklinite, and amorphous SiO_2 matrices, which are the same texture as that in all the other CsMPs. Semi-quantitative analysis of the major constituents for all the CsMPs illustrated a negative linear correlation in (Fe+Zn) vs Si and Cs vs Si diagrams, whereas Fe is positively correlated with Zn. The trend clearly indicates that the CsMPs underwent the same formation processes. Consequently, the CsMPs can be tranported through the river mainly during floods, and flowed into the ocean.