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Characterizing fallout material using Cs and Pu atom ratios in environmental samples from the FDNPP fallout zone

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Here we report the use of combined of Cs and Pu isotope measurements to investigate the extensive plumes of radioactive fallout from the disaster at Fukishima Daiichi nuclear power plant (FNDPP) in March 2011. Among the aims of our study are improved assessment of the physico-chemical nature and changing distribution of land-based fallout. 135Cs/137Cs and 134Cs/137Cs atom ratios are indicative of conditions that relate to the nuclear fission reactions responsible for producing the respective radiocaesium isotopes, and offer much more in terms of forensic and chronological analysis than monitoring 137Cs alone.

We briefly present methods to quantify the atom ratios of Cs and Pu isotopes in soil, lichen and moss samples from FDNPP catchment using mass spectrometry (ThermoTRITON for Cs and ThermoNEPTUNE for Pu). High precision data from Fukushima are presented (e.g decay corrected 135Cs/137Cs atom ratio = 0.384 $\pm$ 0.001 (n = 5) for roadside dust from Iitate region), and these are in agreement with prelimary estimates by others. We also confirm results for IAEA-330, a spinach sample collected from Polesskoe, Ukraine and subject to contamination from the Chernobyl accident. In addition to Cs isotopes, we adopt Pu isotopes to add a further dimension to the forensic analysis. We discuss the corrections required for background levels prior to the disaster, possibility for multiple components of fallout and complicating factors associated with remobilisation during the clean-up operation.

In parallel with this work on digests and leaches from bulk environmental samples, we are refining methods for particle identification, isolation and characterisation using a complementary sequence of cutting-edge materials and manipulation techniques, including combined electron microscopy, focused ion beam techniques (Dualbeam), nano/micro manipulators and nano-scale imaging x-ray photoelectron spectroscopy (NanoESCA) and microCT.