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Retrospective reconstruction of Ioidne-131 distribution at the Fukushima Daiichi Nuclear Power Plant accident by analysis of Ioidne-129

Hiroyuki Matsuzaki (1), Yasuyuki Muramatsu (2), Chiaki Toyama (2), Takeshi Ohno (2), Haruka Kusuno (1), Yasuto Miyake (1), and Maki Honda (3)

(1) School of Engineering, The University of Tokyo, Tokyo, Japan (hmatsu@n.t.u-tokyo.ac.jp), (2) Faculty of Sciences, Gakushuin University, Tokyo, Japan, (3) Graduate School of Integrated Basic Sciences, Nihon University, Tokyo, Japan

Among various radioactive nuclides emitted from the Fukushima Daiichi Nuclear Power Plant (FDNPP) accident, Iodine-131 displayed high radioactivity just after the accident. Moreover if taken into human body, Iodine-131 concentrates in the thyroid and may cause the thyroid cancer. The recognition about the risk of Iodine-131 dose originated from the experience of the Chernobyl accident based on the epidemiological study [1]. It is thus important to investigate the detailed deposition distribution of I-131 to evaluate the radiation dose due to I-131 and watch the influence on the human health. However I-131 decays so rapidly (half life = 8.02 d) that it cannot be detected several months after the accident.

At the recognition of the risk of I-131 on the Chernobyl occasion, it had gone several years after the accident. The reconstruction of I-131 distribution from Cs-137 distribution was not successful because the behavior of iodine and cesium was different because they have different chemical properties. Long lived radioactive isotope I-129 (half life = 1.57E+7 yr,), which is also a fission product as well as I-131, is ideal proxy for I-131 because they are chemically identical. Several studies had tried to quantify I-129 in 1990's but the analytical technique, especially AMS (Accelerator Mass Spectrometry), had not been developed well and available AMS facility was limited. Moreover because of the lack of enough data on I-131 just after the accident, the isotopic ratio I-129/I-131 of the Chernobyl derived iodine could not been estimated precisely [2]. Calculated estimation of the isotopic ratio showed scattered results.

On the other hand, at the FDNPP accident detailed I-131 distribution is going to be successfully reconstructed by the systematical I-129 measurements by our group. We measured soil samples selected from a series of soil collection taken from every 2 km (or 5km, in the distant area) meshed region around FDNPP conducted by the Japanese Ministry of Science and Education on June, 2011. So far more than 500 samples were measured and determined I-129 deposition amount by AMS at MALT (Micro Analysis Laboratory, Tandem accelerator), The University of Tokyo. The measurement error from AMS is less than 5%, typically 3%. The overall uncertainty is estimated less than 30%, including the uncertainty from that of the nominal value of the standard reference material used, that of I-129/I-131 ratio estimation, that of the "representativeness" for the region by the analyzed sample, etc. The isotopic ratio I-129/I-131 from the reactor was estimated [3] (to be 22.3 +- 6.3 as of March 11, 2011) from a series of samples collected by a group of The University of Tokyo on the 20th of April, 2011 for which the I-131 was determined by gamma-ray spectrometry with good precision. Complementarily, we had investigated the depth profile in soil of the accident derived I-129 and migration speed after the deposition and found that more than 90% of I-129 was concentrated within top 5 cm layer and the downward migration speed was less than 1cm/yr [4].

From the set of I-129 data, corresponding I-131 were calculated and the distribution map is going to be constructed. Various fine structures of the distribution came in sight.

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