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福島第一原子力発電所事故前後における土壌中の ^{129}I と ^{137}Cs の深度分布
Depth profiles of ^{129}I and ^{137}Cs in soil before and after the FDNPP accident

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Massive nuclear fission products such as radioiodine and radiocesium were deposited on the land surface of Fukushima via radioactive pollution plumes derived from the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) accident. In order to evaluate inventory and penetration of accident-derived ^{129}I and ^{137}Cs in the land surface, depth profiles of ^{129}I, ^{129}I / ^{127}I atomic ratio and ^{137}Cs in 30-cm-long soil cores before (May 2008) and after (November 2012) the accident were compared at two sites (Iw-2 and Iw-8) on the western area within 10 km from the FDNPP.

Total ^{129}I inventories in soil core at two sites after the accident were estimated to be 0.74 - 1.96 Bq m^{-2}, 14 - 34 times higher than those before the accident (53.6 - 57.0 mBq m^{-2}). Average ^{129}I / ^{127}I ratios ((1.4 - 6.2) $\times$ 10^{-7}) in soil core after the accident were consistent with the ^{129}I / ^{127}I ratio of the radioactively-contaminated surface soils in Fukushima (1.5 $\times$ 10^{-8} - 7.2 $\times$ 10^{-6}, Miyake et al., 2012). We also estimated that total ^{137}Cs inventories after the accident were 0.60 - 3.15 MBq m^{-2}, 280 - 470 times higher than those before the accident (2.1 - 6.7 kBq m^{-2}). Average ^{134}Cs / ^{137}Cs activity ratios (1.07 - 1.08) in soil core fell within the activity ratio in Unit 1 - 3 (0.94 - 1.08) of the FDNPP calculated by ORIGEN2 code (Nishihara et al., 2012). These results suggested that accurate total inventories of accident-derived ^{129}I and ^{137}Cs in soil could be determined by deduction of those backgrounds at almost same site, thus, the FDNPP accident caused ^{129}I deposition of 0.69 - 1.90 Bq m^{-2} and ^{137}Cs deposition of 0.59 - 3.14 MBq m^{-2} on the western area within 10 km from the FDNPP. Moreover, deposited ^{129}I and ^{137}Cs at Iw-2 (4.2 km west from the FDNPP) were respectively, 2.9 and 5.3 times higher than those at Iw-8 (8.4 km west from the FDNPP).

Depth profiles of ^{129}I concentration, ^{129}I / ^{127}I atomic ratio and ^{137}Cs concentration before the accident were essentially declined from upper layer with depth at two sites. On the basis of the highest values in these profiles, background levels were determined to be 420 $\pm$ 11 Bq kg^{-1} for ^{129}I, 1.6 $\pm$ 0.1 $\times$ 10^{-8} for ^{129}I / ^{127}I and 48 $\pm$ 2.5 Bq kg^{-1} for ^{137}Cs. After the accident, significant elevated values of ^{129}I (40.2 - 130 mBq kg^{-1}), ^{129}I / ^{127}I ((0.9 - 9.3) $\times$ 10^{-6}) and ^{137}Cs (44.6 - 255 kBq kg^{-1}) were found in the uppermost layer at the two sites, then these profiles exponentially declined with depth. Approximately 90% of deposited ^{129}I and ^{137}Cs at two sites were absorbed upper 37.4 - 50.5 kg m^{-2} (4.1 - 4.3 cm) and upper 13.3 - 21.3 kg m^{-2} (1.0 - 3.1 cm) in depth, respectively. In addition, since the relaxation mass depths (h_0) of ^{129}I were 9.2 - 12.8 kg m^{-2} greater than those of ^{137}Cs (6.8 - 11.7 kg m^{-2}) at two site, radioiodine was considered to penetrate slightly deeper than radiocesium in upper layer of both sites as Kato et al. (2012) found at 40 km northwestern site from the FDNPP. This is not contradicting to increasing tendency of ^{129}I / ^{137}Cs activity ratio with depth at both sites. Based on the fact that both ^{129}I and ^{129}I / ^{127}I in soil after the accident declined to a background level under 84.8 kg m^{-2} in depth at Iw-2 and under 133 kg m^{-2} in depth at Iw-8, about 8 - 9% of accident-derived ^{129}I were likely to penetrated 37.4 - 84.8 kg m^{-2} (4.3 - 8.6 cm) in depth at Iw-2 and 50.5 - 133 kg m^{-2} (4.1 - 10.2 cm) in depth at Iw-8.

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