Contribution ID: **149** Contribution code: **PSB-13** Type: **Poster**

Study on the migration behaviour of Fukushima accident-derived I-129 from land area to the marine environment

Wednesday, 23 October 2024 17:55 (20 minutes)

The March 2011 accident at the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) in Japan resulted in the massive release of high-volatility fission products, including ^{129}I (8.1 GBq) and ^{131}I (120–160 PBq). The long-lived ^{129}I ($T_{1/2}$ = 15.7 million years) is one of the important radionuclides that we need to evaluate its migration behaviour from Japan’s land area to the marine environment because of its relatively high chemical reactivity, biological concentration in the marine ecosystem, and affinity for the thyroid gland although it is less radiologically harmful than the short-lived ^{131}I ($T_{1/2}$ = 8.02 days). The present study aimed to evaluate the following three points: 1) the source and the discharge of particulate ^{129}I in the Niida River, 2) ^{129}I distribution in the marine sediment around the mouth of the Niida River, and 3) ^{129}I distribution in the seawater and the marine organism in an area close to the FDNPP. In the Niida River system where the upstream is in the relatively high-contaminated area located 30–40 km northwest of the FDNPP, total suspended solids (SS) each month from December 2012 to January 2014 were continuously collected at the Haramachi site (5.5 km upstream from the river mouth) of the downstream river by installing the time-integrative SS sampler. Marin surface sediments (0–3 cm depth) were collected at the two sites within 2 km from the mouth of the Niida River. On the other hand, seawater samples of 2 L in water depths of 0 m, 5 m, 10 m, 15 m, and 20 m, and rockfish were collected at a site 6 km south-southeast of the FDNPP in July 2014. The iodine in SS, sediment, and rockfish of 0.2–0.5 g was volatilized and trapped in an organic alkaline solution by pyrohydrolysis method. After adding 2 mg iodine carrier to the trap solution and the filtered water sample of 1 L, the iodine was isolated and precipitated as AgI. The ^{129}I/^{127}I ratio of AgI targets was measured using an AMS system at the Micro Analysis Laboratory Tandem Accelerator (MALT), The University of Tokyo. ^{127}I in the trap solution and the water sample were measured by an ICP-MS. The original ^{129}I activities and ^{129}I/^{127}I ratios in the samples were calculated using ^{127}I concentration obtained from ICP-MS and ^{129}I/^{127}I ratio obtained from AMS. ^{129}I activities and ^{129}I/^{127}I ratios in SS of the Niida River were 0.9–4.1 mBq kg^{-1} and (2.5–4.4)×10^{-8}, which were strongly correlated with the total dry weight of monthly SS samples with correlation coefficient (R^2) of over 0.79. ^{129}I activity and ^{129}I/^{127}I ratio in SS were considered to infer the source of SS (relatively high-level contaminated upstream area or low-level contaminated downstream area). Meanwhile, the discharged particulate ^{129}I at the Haramachi site were estimated to be 7.7–12 kBq month^{-1} from September to October 2013. Therefore, a relatively massive amount of particulate ^{129}I from the upstream was transported to the downstream of the Niida River from September to October 2013. ^{129}I activities in the surface marine sediments from two sites within 2 km from the mouth of the Niida River were 5.8–8.4 Bq kg^{-1}, 2–3 orders of magnitude lower than that of SS at Haramachi site of the Niida River. The ^{129}I activity in surface seawater 40 months after the accident was 2.2 μBq L^{-1}, 2 times larger than the previous ^{129}I data in surface seawater 3 months after the accident. ^{129}I activities in the rockfish were 42–48 μBq kg^{-1}, approximately 20–400 times larger than that of seawater of the same site.

Student Submission

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Primary author: MATSUNAKA, Tetsuya (Kanazawa University)

Co-authors: Dr SASA, Kimikazu (University of Tsukuba); Dr SUEKI, Keisuke (University of Tsukuba); Mrs MATSUMURA, Masumi (University of Tsukuba); Mr TAKAHASHI, Tsutomu (University of Tsukuba); Dr MATSUZAKI, Hiroyuki (MALT, The University of Tokyo, Japan)

Presenter: MATSUNAKA, Tetsuya (Kanazawa University)

Session Classification: Poster Session B

Track Classification: Applications in Oceanography