Development of a sensitive radioiodine analytical method by ICP-MS/MS and its application to environmental radioactivity research

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The long-lived radioiodine isotope ^{129}I (half-life:1.57×10^7 years) is one of the most important radionuclides released from nuclear fuel reprocessing plants and nuclear accidents into the environment. This is because ^{129}I has been used as a tool to reconstruct the distribution of ^{131}I (half-life:8 days) at nuclear accidents. The accident at the Fukushima Daiichi nuclear power plant (FDNPP) resulted in a substantial release of radioiodine, including ^{131}I, into the environment. Accelerator mass spectrometry (AMS) has been used for the determination of ^{129}I in the soil samples contaminated by the FDNPP accident. Unfortunately, there are few facilities equipped to carry out this analysis and the opportunity of applying this method to large numbers of samples is limited.

Recently, a triple quadrupole ICP-MS (ICP-MS/MS) was concerned to measure $^{129}I/^{127}I$. However, there are several challenges in measuring iodine-129 by ICP-MS; the isobaric interference produced by ions such as $^{127}IH_2^+$ (where $^{127}IH_2^+/^{127}I^+ = 3 \times 10^{-8}$) meant that the determination of ^{129}I in less contaminated soils could not be carried out. The aim of this study is the development of a gas sample introduction technique by oxidization of iodine for ICP-MS/MS.

The sample preparation procedure used in this study consists of separation of iodine from soil samples by pyrohydrolysis. We used a gas sample introduction system equipped with 3 channels. In this system, iodine in the aqueous solution was oxidized and vaporized by adding the HNO_3 and $NaNO_2$, and then, introduced into ICP-MS/MS.

The signal intensity of the developed method improved more than 10 times higher than that of the traditional solution nebulizing introduction. This result suggests that transmission efficiency and ionization efficiency can be improved. While AMS required time-consuming pretreatments such as solvent extraction, the developed method is relatively simple. Therefore, the method using ICP-MS/MS can be helpful for the analysis of the urgent samples related to a nuclear power plant accident.