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Sources and the distribution of 129I in soils from northeast China

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Human nuclear activities including nuclear weapons tests and nuclear accidents have released large amounts of radioactive substances to the environment. Due to the high volatility of iodine and high fission yield of radioactive iodine (129I, 131I), the released radioactive iodine has been dispersed and deposited in a large area. The long-lived iodine-129 is therefore can be used as an ideal tracer for investigation on the dispersion of radioactive substances in the atmosphere and the assessment of environmental impact, meanwhile to study environmental process.

About 100 surface soil samples (0-5 cm) collected from Northeast China in 2014 were analyzed for 129I and 127I concentrations using accelerator mass spectrometry and ICP-MS after chemical separation of iodine from the sample matrix and other interferences. The concentrates of 127I in the soil samples are 0.13-10.07 μg/g, with an average of 2.67 μg/g, which is consistent with the observed value in a large spatial scale of China. The variation trend of 127I concentrations shows high values in the southeast region, which is attributed to the organic matter content in the soils and the high precipitation rate in this region.

The 129I/127I atomic ratios vary in 2.61×10-10 -6.49×10-8, which are 2-3 orders of magnitude higher compared to the estimated pre-nuclear level. This level is also consistent with the level observed in other areas in China. Unexpectedly enhanced 129I/127I ratios of more than 1×10-8 were observed in the Mid-eastern Inner Mongolia (MIM). The high 129I level in this region indicates that besides the global fallout, the European nuclear reprocessing plants and nuclear weapon testing in Semipalatinsk and Lop Nor are the fraction of anthropogenic 129I sources in MIM. In addition to the long-range atmospheric dispersal of 129I from nuclear fuel reprocessing plants, the dust and airflow carried 129I deposited in the Asian-dust area, which might be another significant 129I input in the MIM.

In addition to the abundant 129I source, the special atmospheric circulation and the topographical factors have provided favourable conditions for deposition of radioactive materials, which lead to the dust that carried 129I from the Asian-dust area and atmospheric 129I from long-range transportation would be prone to deposition, compared with the relatively arid area of the west.

Finally, the higher vegetation cover and the soil type with higher content of the organic substance in MIM, worked together leading to the effective preservation of the deposited 129I, which is also an important factor for high 129I in MIM.

This work systematically investigated the distribution of 129I in Northeast China for the first time and unexpectedly found a high 129I level in the area far away from the point sources. This feature might shed light on the role of the positive deposition and the effective preservation in the distribution of radionuclides. The implication of 129I as a tracer to understand the mechanisms of regional deposition of radionuclides is essential to allow prediction of future distribution of anthropogenic nuclides and for evaluation of its possible effects on human health.

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