§2. Hydrogen Isotopic Composition in River Water at Toki Site

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Introduction

Tritium (^{3}H) is the radioisotope of hydrogen and it decays to ^{3}He with a half-life of 12.3 y. Most of tritium as natural origin are produced via nuclear reactions between secondary cosmic rays and nitrogen or oxygen atoms in the upper atmosphere. Nuclear facilities also release tritium into the environment. A deuterium plasma experiment is being planned to produce higher-performance plasma at Large Helical Device (LHD). In deuterium experiments, a small amount of tritium will be produced by a fusion reaction. Although tritium will be removed with an efficiency greater than 95% using tritium removal system for safety considerations, small amounts of tritium will be released as gaseous exhaust into the surrounding environment. To evaluate the tritium effect on the environment precisely, it is important to understand the background concentration of tritium in the environment. Recent tritium concentration level is similar to normal detection level. Therefore, it is necessary to enrichment operation of tritium. We measured tritium concentration in river water at collected around NIFS site using liquid scintillation method after the tritium enrichment operation using an electrolytic enrichment system.

Materials and Methods

Figure 1 shows the sampling location of Toki site. The river water samples were collected about 1.0 to 3.0 L in washed polyethylene bottle at 6 points by NIFS environmental monitoring program in 2011 and 2012. Sampling interval is every three months (February, May, August and November). Each water samples about 600 mL was distilled after passed through the membrane filter (pore size, 0.45 μm). The distilled samples were electrolyzed from 500 mL to 74 mL to enrich tritium by an electrolytic enrichment system using solid polymer electrolyte membrane (XZ001, Permelec electrode Ltd., Japan). After distilling the tritium enriched sample water, 65 grams of each sample were mixed with 65 ml of a liquid scintillation cocktail (Ultima Gold LLT, PerkinElmer, USA). The beta-spectra were measured by a low-background liquid scintillation counter (LSC-LB5, Aloka, Japan), and tritium concentrations were calculated.

Results and discussion

Figure 2 shows the seasonal variation of tritium concentration in river water collected at Toki site. Tritium concentration in 6 rivers in 2011 and 2012 ranged from 0.35 to 0.65 Bq/L with mean value (±Standard Deviation; S.D.) of 0.47±0.08 Bq/L. And they are high in February and May, and low in August and November. The source of river water is mainly rain water. It is deposited on watershed and has an influence upon river water according to hydrological process. It is known that tritium concentration in rain water in Japan show seasonal variation which is high in spring and low in summer. The cause of seasonal variation is the difference in the air-mass origin. High-pressure systems develop in the Pacific Ocean in summer, and bring air masses from the ocean which is low concentration. On the other hand, the western monsoon blows in winter to spring, and carries air masses from the Asian continent to the Japanese Island. Relatively higher tritium concentration in precipitation was observed in inland continental areas as a so-called continental effect due to recycling of tritium by evaporation and precipitation. The observed seasonal variation of tritium concentration in river water is similar to general trend of tritium concentration in rain water in Japan. It seems that tritium concentration in river water at Toki site have been an influence from relatively first water circulation in this region. In this study, we found the recent tritium concentration level and its seasonal variation in river water at Toki site. It is difficult to clarify the difference in recent tritium concentrations by general method. Therefore, tritium enrichment technique is necessary to understand the recent tritium concentration level.

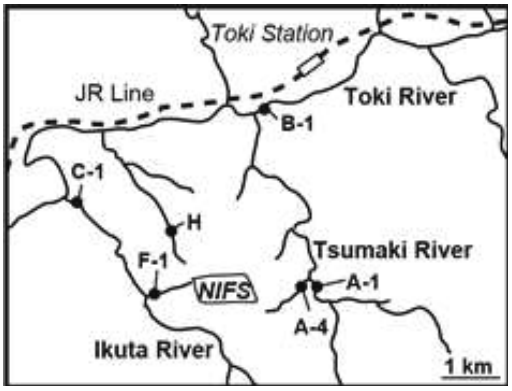

Fig. 1 Sampling points of river water at Toki site in Gifu Prefecture.

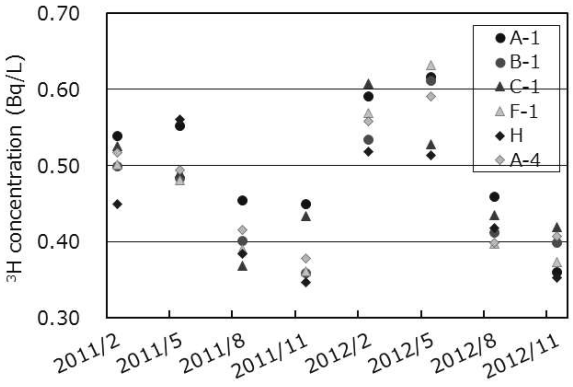

Fig. 2 Seasonal variation of tritium concentrations in river water collected at Toki site.