§10. Study on Behavior of Environmental Tritium at Toki Site

Sugihara, S., Yokoyama, H., Momoshima, N. (RIC, Kyushu Univ.),
Fukutani, S. (Kyoto Univ.),
Tamari, T. (KEEA),
Uda, T., Yamanishi, H., Tanaka, M.

The levels of tritium in the atmosphere are nowadays almost only of natural origin and of the same range as before the era of the nuclear tests. In order to appraise the influence of tritium released from nuclear facilities to the environment, it is necessary to confirm the effect of tritium appearing overlapped on background tritium levels.

The purpose of this work is to confirm the background tritium level in natural water samples at the NIFS site and to understand the tritium behavior which is necessary to evaluate the behavior of the tritium released from the NIFS to the environment. The environmental tritium concentration around the nuclear or fusion facilities must be monitored not only to ensure safety control but also to gain the consent of local residents.

Tritium concentrations and stable isotopes of oxygen and hydrogen in rain water, stream water and groundwater at the NIFS (National Institute for Fusion Science, Gifu prefecture, Japan) site were analyzed to understand behavior of the natural tritium in coupling with rain event. Conductivity, temperature and flow rate of the stream were monitored continuously. Fig. 1 shows the tritium concentration in rain water, stream water, river water, and groundwater samples. The range of tritium concentrations in rain were 0.09-0.78 Bq/l (average 0.37±0.14 Bq/l). The tritium concentration is low in summer and autumn and is high in winter and spring. The average tritium concentrations of stream and river water (R-10, R-15 and Toki River) and groundwater were 0.32±0.04, 0.34±0.06, 0.34±0.03and 0.25±0.02Bq/l, respectively. A significant difference is not observed at the concentrations of the stream and the river waters. As for the tritium concentration of rain, the lower concentrations compared to that of the stream, the river and the groundwater were observed depending on the precipitation period and the rainfall intensity. The tritium concentration of the groundwater is constant approximately through the year regardless the sampling holes. As the average concentration of groundwater was lower than the average concentration of rain, the groundwater at this site may be sufficiently mixed with rain and would have the residence time of a several years.

The stable isotopes of D and ^{18}O in water samples collected in this study were measured with a mass spectrometer (DeltaS, Thermo electron Inc.). A seasonal variation of the δ value which reflects the difference of rain origin in summer and winter was seen in the stable isotopic ratio change of rain in 2007-2009 collected at NIFS site. This is the same as the typical change of rain in Honshu Island, Japan. The δ value of the stream and river waters shows the value of mixed summer and winter precipitation, but with a characteristic distribution of the stable isotopic ratio which is close to the Meteoric Water Line in the summer, what reflects relatively high amount of rainfall in summer season in Japan. The variation range of the stable isotopic ratio in the stream and the river waters is less than 10 % compared with that of rain. This suggests an effective mixing in the ground aquifer at NIFS site.

The two component separation is carried out using the $\delta^{18}O$, the conductivity and the tritium concentration at the rain event (2009/11/10). The results using the $\delta^{18}O$ of the groundwater (-8.1‰) and the rain (-4.2‰) and the conductivity of the groundwater (0.130 μS/cm) and the rain (0.010 μS/cm) make possible to estimate the degree of mixing of the old water and the new water. The mixing trends in $\delta^{18}O$ and conductivity are similar. However, the tritium concentration did not give the similar result, because the tritium concentration of the groundwater was lower than that of the stream water in this rain event. The seasonal variation of tritium concentration in rain should be considered as another factor controlling the tritium concentration of groundwater at NIFS site. The tritium data gives variable information as far as groundwater age which is difficult to derive from $\delta^{18}O$ and conductivity.

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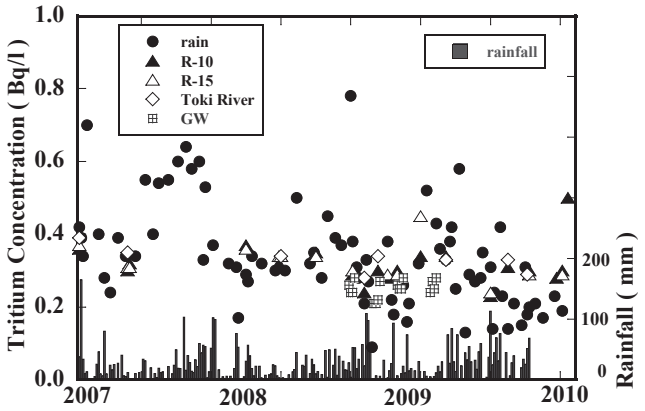

Fig. 1 Tritium Activity in rain, stream water (R-10, R-15), river water (Toki), and groundwater at NIFS site