§28. Investigation on Environmental Behavior of Organically Bound Tritium

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OBT (Organically Bound Tritium) plays a key role in radiation exposure to tritium because OBT ingested through foods occupies a considerable fraction of tritium intake in man.[1)] The OBT can be defined by two fractions: the exchangeable fraction and the non-exchangeable fraction. Exchangeable OBT is essentially fixed in the labile site for hydrogen of the material in plants, and is in isotopic equilibrium with free water of plants and thus reflects tritium level of the local atmospheric moisture and soil water. By contrast, non-exchangeable OBT is directly bound to carbon atom tightly through photosynthesis, and no longer related to the local environmental hydrogen isotope composition change after its incorporation. It would represent an integration of the environmental tritium level during the growing periods.

A standardized OBT measurement method is not well established. OBT measurements were carried out by two different methods (Fig.1) for the grass sample which was treated with tritium free water to elucidate exchangeable and non-exchangeable fractions.

The non-exchangeable OBT concentrations determined by radiometry are shown in Table 1. The non-exchangeable OBT concentration is 47.2 ± 4.6 Bq/L as an average, ranging from 39.7 to 51.8 Bq/L, which gives 24.9 ± 2.4 Bq/kg dry matter as an average, ranging from 20.9 to 27.3 Bq/kg dry matter under the assumption that 5.86 % hydrogen content determined by elemental analysis.

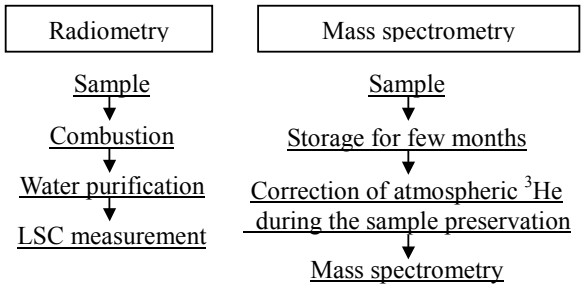

Fig. 1. The flow diagram of radiometry and mass spectrometry

By mass spectrometry, 26.3 ± 0.7 Bq/kg dry matter is obtained as an average for the non-exchangeable OBT, ranging from 25.2 to 27.0 Bq/kg dry matter. The OBT of 35.1 ± 3.8 Bq/kg dry matter is obtained for the grass sample without washing as an average, ranging from 30.6 to 40.5 Bq/kg dry matter. The hydrogen content of the sample is not necessary to OBT calculation by mass spectrometry. The non-exchangeable OBT concentrations of 24.9 ± 2.4 Bq/kg and 26.3 ± 0.7 Bq/kg obtained by the radiometry and mass spectrometry are in a good agreement suggesting a validity of the two methods for the OBT determination.

The OBT in the present environmental samples in Japan would be less than a few Bq/kg dry matter which is low compared to the present grass sample from France. The determination of OBT concentration by the combination of combustion technique and LSC would be applicable to rough estimations of the background tritium level in the environment and to monitoring tritium around nuclear facilities which release tritium. At present mass spectrometry would be the most powerful tool to examine tritium behavior at general environment.

1) UNSCEAR: Sources and Effects of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation (2000).

Table 1 OBT concentrations in the grass sample determined by radiometry and mass spectrometry

Run	Non-exchangeable OBT*		Exchangeable OBT + Non-exchangeable OBT
	Combustion – LSC		Mass spectrometry
	Bq/L combustion water	Bq/kg dry matter	Bq/kg dry matter	Bq/kg dry matter
1	39.7 ± 0.6**	20.9 ± 0.3**	26.6 ± 0.2	33.7 ± 0.5
2	47.0 ± 0.6	24.8 ± 0.3	26.2 ± 0.3	40.5 ± 0.5
3	51.8 ± 0.7	27.3 ± 0.4	27.0 ± 0.3	30.6 ± 0.7
4	48.6 ± 0.8	25.6 ± 0.4	25.2 ± 0.1	37.1 ± 0.6
5	49.1 ± 0.7	25.9 ± 0.4		33.7 ± 0.7
Average	47.2 ± 4.6***	24.9 ± 2.4***	26.3 ± 0.7***	35.1 ± 3.8***

* Decay corrected to 2009-08-24. ** Counting error. *** Standard deviation.