§19. Investigation of Lithium Isotope Ratios in Natural Water for Resource Supply to Nuclear Fusion Reactor

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The deuterium-tritium (D-T) fusion reactor is expected to be a system to provide the main electricity in the future without any serous release of hazardous products such as a radioisotope of tritium, and it is the easiest fusion reaction to achieve. Lithium will be required in amounts dependent on the reactor design concept. When liquid lithium is used as a tritium breeder and a coolant, lithium inventories are large [1]. Lithium is now recovered from the mines and from salt lakes which contains about 33 million tons of lithium globally [2]. Although the amount of lithium in those resources is quite insufficient at this point, alternative resources should be found to satisfy lithium inventories for nuclear fusion plants and the increasing demand for battery and so on in the near future.

Naturally occurring lithium (chemical symbol Li) (standard atomic mass: 6.941(2) atomic mass units, a.m.u.) is composed of two stable isotopes, lithium-6 and lithium-7, with the latter being by far the more abundant one: about 92.5 percent of the atoms. Lithium-6 is an important isotope in the deuterium-tritium (D-T) fusion reactor because tritium is produced from the reaction: $^{6}Li + {}^{1}n \rightarrow {}^{4}He + {}^{3}H$ (tritium) + 4.78 MeV. Therefore, it is important point to secure the amount of ^{6}Li to operate nuclear fusion reactor.

Japan is oceanic and volcanic country, and development of these resources is important issue in 21st century. Seawater, which contains 2300 hundred million tons of lithium in total [3] and geothermal water (hot spring water) containing Li content, has thus recently become an attractive source of this element. The separation and recovery of lithium from these natural water resources by co-precipitation, solvent extraction, adsorption, etc. have been investigated [4-7].

In this research, we will estimate ^{6}Li contents in various natural waters, so firstly total Li content and other typical elements in natural water were investigated.

Five different types of samples, seawater, geothermal water, hot spring water, ground water and tap water, were used in this study. Seawater was collected from the surface layer of Imari Bay, Saga prefecture. Two geothermal waters were collected from injection well of Geothermal power plants in Sumikawa and Ohnuma, Akita prefecture. Three hot spring waters were collected from hot springs in Gero, Shitajima, and Nigorigo, Gifu prefecture. Ground water was collected from Tounou mine, Gifu prefecture. Tap water was collected from National Institute for fusion science,Toki, Gifu prefecture.

The concentrations of Li^{+} and isotopic ratios of ^{6}Li / ^{7}Li in the samples was measured by ICP mass spectrometry (ICP-MS) using LSVEC (Lithium carbonate) as standard.

Table 1 shows lithium concentrations and isotopic ratios of ^{6}Li / ^{7}Li of various natural waters. Samples has lithium content with different concentration, coexisting with various other contents. Regardless of lithium concentrations and sample types, isotopic ratios of ^{6}Li / ^{7}Li in samples are almost constant.

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Sample	Sampling point	Concentration (mg/L)	Percentage of ^{6}Li and ^{7}Li		Isotopr ratio
			^{6}Li (%)	^{7}Li (%)	($^{6}Li/^{7}Li$)
Tap water	Toki, Gifu	0.003	7.4	92.6	0.080
Seawater	Imari, Saga	0.17	7.6	92.4	0.082
Ground water	Tounou mine, gifu	0.07	7.4	92.6	0.080
Hot spring water	Gero, Gifu	1.13	7.4	92.6	0.080
	Shitajima, Gifu	9.70	7.5	92.5	0.081
	Nigorigo, Gifu	1.62	7.4	92.6	0.080
Geothermal water	Sumikawa, Akita	1.69	7.4	92.6	0.080
	Ohnuma, Akita	1.02	7.6	92.4	0.082