Groundwater flow system in Fukushima Prefecture, Japan, traced by tritium-^{3}He, ^{4}He and ^{14}C dating methods and ^{129}I/^{127}I ratio

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For effective utilization of groundwater resources, it is necessary to understand the large-scale circulation of water [1]. In particular, studying the residence time and source of the water is important for evaluating the groundwater flow system. For Fukushima Prefecture, northeastern Japan, there are few reports on the behavior and contamination status of groundwater affected by radionuclides released by the accident at the Fukushima Daiichi Nuclear Power Plant triggered by the earthquake of 11 March 2011 off the Pacific coast of Japan and the subsequent tsunami. We investigated the groundwater flow system in the Fukushima Hama-dori region and the anthropogenic contamination of groundwater caused by the nuclear accident using the ^{3}H–^{3}He dating method, with which it is possible to acquire the age of groundwater and information on the water source based on the initial ^{3}H concentration and ^{129}I, one of the radionuclides released by the nuclear accident. The results were compared with ^{14}C and ^{4}He ages to identify mixing between recent (post-1950’s) and old water (up to 1 million years).

A high ^{3}H concentration of 9 T.U. associated with the age consistent with the date of the nuclear accident within analytical error was observed at only one of the 27 sampling sites. Some samples with which ^{3}H-^{3}He ages were determinable showed significantly older ^{14}C and/or ^{4}He ages than the upper limit of ^{3}H-^{3}He method, indicating mixing between recent and old water. For some samples, measured ^{14}C ages were older than those estimated from mixing ratios of old and recent water based on their ^{3}H concentrations, which suggests additional “dead” carbon supplies from their aquifer. The ^{129}I/^{127}I ratios of almost all samples were lower than the recent precipitations [2] but significantly higher than the lower limit of the value of anthropogenic iodine (1.5×10^{-12}) [3], indicating mixing of older water than 1950’s to the recent water. Until the present, the apparent groundwater contamination due to the nuclear accident has not been confirmed except at the single site with high ^{3}H and less than 10 years residence time, though the possibility that polluted water might discharge in the future cannot be ruled out.

[1] Mahara (1996), *RADIOISOTOPES*, **45**, 435-445. [2] Toyama *et al.* (2012) *J. Environ. Radioact.*, **113**, 116-122. [3] Fehn (2012) *Annu. Rev. Earth Planet. Sci.*, **40**, 45-67.

Keywords: tritium-3He age, 14C age, 4He age, 129I/127I ratio, oxygen and hydrogen stable isotope ratio, Fukushima Daiichi Nuclear Power Plant

