

## Age dating of spring water, groundwater and stream water in mountainous watersheds using multi-tracer approach

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This study aims at estimation of mean residence time (MRT), to reveal the spatial distribution using multi-tracer approach in mountainous catchment, and to make clear relationship between hydrological characteristics and the variation of the residence time. First, we conducted field survey and sampling in Kiryu Experimental Watershed, in southern Shiga, in June, August and October, 2013 and analyze major dissolved inorganic ions, SiO<sub>2</sub>, chlorofluorocarbons (CFCs) and stable isotopes (SI). Second, we estimated MRT using CFCs. We also evaluate MRT using seasonal variation of SI of rainfall, groundwater and stream water that collected monthly from 2008 to 2012.

The MRT of stream water and groundwater were estimated to be ranging from approximately 2.8 to 4.4 years by using SI as tracers. The MRT of spring water and groundwater were estimated to be ranging from 1.5 to 8.5 years and 15 to 23 years, given a water temperature as recharge temperature using CFCs. The relationship between Na<sup>+</sup> concentration and MRT based on CFCs suggested that short MRT that provided from decrease trend in atmospheric CFCs concentration is appropriate.

The MRT of water by CFCs ranged from 1.5 to 8.5 years, whereas that by SI ranged from 2.8 to 4.4 years in this catchment. This result conforms that of previous studies using SI, however the MRT by CFCs shows larger value range because CFCs represent time resolution information. In addition, the MRT varies in time and space due to mixing of different subsurface flow with different MRT and flow path.

Keywords: multi-tracer approach, mean residence time, stable isotope, chlorofluorocarbons