

Integrated study on spatiotemporal variation of residence time in spring and groundwater at headwater catchments

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We performed an investigation on spatial and temporal variation of residence time in spring water and groundwater using SF₆, CFCs, and microbe, and an evaluation of groundwater storage volume based on water budget analysis in multiple headwater catchments underlain by different lithology. Also, we investigated a temporal variation of residence time and the microbe information in spring water at a small forested headwater catchment underlain by granite, Fukushima, Japan.

The spring water age ranges from less than one year to more than 20 years, and the storage volume of the groundwater ranges from 10³ m³ to 10⁶ m³ in volume in the headwaters in Japan. The age of the spring water varies from less than one year to more than 10 years, and it tends to show high values specifically during the rainstorm events, whereas that is lower than 10 years during the rainless periods. Also, during the rainless periods, the age of the spring water is younger in the high flow rate, whereas that is older in the low flow rate. During the rainstorms, the age of the spring water is older in the high flow rate as compared with that in the low flow rate.

In the groundwater and the spring water at the hillslope scale, the age becomes younger, the total number of the prokaryotes becomes smaller, and the microbial diversity becomes higher from the ridge toward to the valley, from the recharge area to the discharge area, considering the groundwater flow system. From the viewpoints of the multiple headwater catchments, the microbial diversity tends to be lower in the spring water with the longer residence time.

The microbial information in quantity and quality is affected by the groundwater flow system in addition to the biological environment, and the microbe information would be possibly used as the tracer of the groundwater flow.

Keywords: residence time, groundwater, spring water, headwater catchment