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Spatial distribution of residence time, microbe and storage volume of groundwater in headwater catchments

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Headwater catchments in mountainous region are the most important recharge area for surface and subsurface waters, and time and stock information of the water is principal to understand hydrological processes in the catchments. Also, a variety of microbes are included in the groundwater and spring water, and those varies in time and space, suggesting that information of microbe could be used as tracer for groundwater flow system. However, there have been few researches to evaluate the relationship among the residence time, microbe and storage volume of the groundwater in headwater catchments. We performed an investigation on age dating using SF_6 and CFCs, microbe counting in the spring water, and evaluation of groundwater storage volume based on water budget analysis in 8 regions underlain by different lithology, those are granite, dacite, sedimentary rocks, serpentinite, basalt and volcanic lava all over Japan. We conducted hydrometric measurements and sampling of spring water in base flow conditions during the rainless periods 2015 and 2016 in those regions, and SF_6, CFCs, stable isotopic ratios of oxygen-18 and deuterium, inorganic solute concentrations and total number of prokaryotes were determined on all water samples.

Residence time of spring water ranged from 0 to 16 years in all regions, and storage volume of the groundwater within topographical watershed was estimated to be 0.1 m to 222 m in water height. The spring with the longer residence time tends to have larger storage volume in the watershed, and the spring underlain by dacite tends to have larger storage volume as compared with that underlain by sand stone and chert. Also, total number of prokaryotes in the spring water ranged from 10^3 to 10^5 cells/mL, and the spring tends to show clear increasing of total number of prokaryotes with decreasing of residence time. Thus, we observed a certain relationship among residence time, storage volume and total number of prokaryotes in the spring water, and these parameters are effective to evaluate hydrological characteristics in the headwaters, and the microbe information could be an excellent tracer for groundwater flow research.