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Spatial and temporal variation of residence time and microbe in spring and groundwater at headwater catchments

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A variety of microbes are included in the spring water and the groundwater, and those vary in time and space, suggesting that information of microbe could be used as a tracer for groundwater flow system. However, there have not been enough studies to investigate the spatio-temporal dynamics of microbe in the groundwater. We focused on mountain hillslope and a headwater catchment where the hydrological data is available, and monitored the residence time, chemical characteristics, density of prokaryotes and microbial community composition in the spring water and the groundwater on the ridge, the hillslope and the valley bottom with the hydrometric and the groundwater data. We sampled the spring water and the groundwater with total number of 57 from October 2015 through August 2017 at Mt. Fuji area, Shizuoka prefecture and Mt. Setohachi area, Fukushima prefecture, Japan.

The density of prokaryotes in the spring water and the groundwater ranges from 10^2 to 10^3 cells/mL in Mt. Fuji area, and from 10^3 to 10^5 cells/mL in Mt. Setohachi area. Specifically, the water with SF_6 age younger than 20 years tends to show a wide range of density of prokaryotes ranging from 10^3 to 10^6 cells/mL, whereas the water with the age older than 20 years tends to show a low density of prokaryotes in the order of 10^3cells/mL. This suggests that the older groundwater includes smaller amount of prokaryotes as compared with the younger groundwater.

The diversity of microbial community composition in the spring and the groundwater is higher on the ridge than that on the hillslope and the valley bottom, suggesting the diversity of microbial community composition becomes low along with groundwater flow from the recharge area to the discharge area. Additionally, the microbial community composition in the groundwater on the ridge shows a clear seasonal change, whereas that on the hillslope and the valley does not show change among the seasons. The microbial community composition in the groundwater seems to become stable and homogeneous in the discharge area as compared with that of the recharge area. This shows that the groundwater flow process also effects on the spatio-temporal variation of the microbial community composition in the groundwater.