

Spatial distribution of residence time and total number of prokaryotes in spring water in headwater catchments underlain by different lithology

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The residence time in the spring water and groundwater is principle to understand the groundwater flow system in the mountainous area. Chlorofluorocarbons (CFCs) and Sulfur hexafluoride (SF₆) are useful as the tracers for age dating of the young groundwater, especially it is effective in the headwaters Japan, where the young groundwater less than 50 years is dominant. Also, a possibility of microbe as a tracer for groundwater flow path has been investigated recently, however, there are few studies focusing on the relationship between residence time and total number of prokaryotes in the groundwater in different lithology. In this study, we focused on the spring water, and estimated the residence time using CFCs and SF₆ as tracers, and counted the total number of prokaryotes in mountainous headwater catchments underlain by granite, sedimentary rock, basalt, and serpentine, Japan, and spring located Christchurch area underlain by marine sediment, New Zealand. We aim to investigate the spatial distribution of the residence time and the microbe information in the spring water focusing on the groundwater flow dynamics in Japan and New Zealand. The residence time in granite area ranged from 2.2 years to 29.4 years and that in sedimentary rock area ranged from 7.8 years to 15.5 years. The total number of prokaryotes ranged from 10³ to 10⁵ cells/mL in granitic area and 10⁴ to 10⁶ cells/mL in sedimentary rock area. The total number of prokaryotes in the spring water with younger residence time tends to show wide variation in values ranging from 10³ to 10⁶ cells/mL, whereas that of older spring water tends to converge on 10³ cells/mL. Generally, the groundwater with older residence time has deeper groundwater flow path, also, there is a report that the total number of prokaryotes in the groundwater decreases with depth. Therefore, we could find a relationship between the residence time and total number of prokaryotes. In addition, the total number of prokaryotes tends to be smaller as the groundwater storage becomes larger. It seems to be explained by the groundwater flow characteristics mentioned above.

Keywords: Chlorofluorocarbons, Sulfur hexafluoride, total number of prokaryotes, residence time, groundwater storage