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Microbial DNA; a possible tracer of groundwater

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Though chemical analysis of groundwater shows an averaged value of chemistry of the examined water which was blended by various water with different sources and routes in subsurface environment, microbial DNA analysis may suggest the place where they originated, which may give information of the source and transport routes of the water examined.

A huge amount of groundwater is stored in lava layer with maximum depth of 300m in Mt. Fuji (3,776m asl), the largest volcanic mountain in Japan. Although the density of prokaryotes was low in the examined groundwater of Mt. Fuji, thermophilic prokaryotes as *Thermoanaerobacterales*, *Gaiellales* and *Thermoplasmatales* were significantly detected. They are optimally adapted to the temperature higher than 40^{o}C. This finding suggests that at least some of the source of the examined groundwater was subsurface environment with 600m deep or greater, based on a temperature gradient of 4^{o}C/100m and temperature of spring water ranges from 10 to 15^{o}C in the foot of Mt. Fuji. This depth is far below the lava layer. Thus, the groundwater is not simply originated from the lava layer.

In addition to those findings, we observed a very fast response of groundwater just a couple of weeks after the heavy rainfall exceeding 2 or 300 mm/event in Mt. Fuji. The fast response was suggested by a sharp increase in bacterial abundance in spring water located at 700m in height in the west foot of Mt. Fuji, where the average recharge elevation of groundwater was estimated to be 1,500m - 1,700m (Kato *et. al.* EGU 2016). This increase was mainly provided by soil bacteria as *Burkholderiales*, which might be detached from soil by strengthened subsurface flow caused by heavy rainfall. This suggests that heavy rainfall promotes shallow subsurface flow contributing to the discharge in addition to the groundwater in the deep aquifer.

Microbial DNA, thus could give information about the route of the examined groundwater, which was never elucidated by analysis of chemical materials dissolved in groundwater. Though viral particle was employed as a tracer to chase the movement of groundwater, it doesn't tell the chemical and physical environmental condition where the particle was incorporated into groundwater. Thus, we propose microbial DNA as a new tracer to track the route of groundwater.